I begin building some HAM receivers as boy in age of 13 in elementary school . It was simple construction after that I build more and more and electronics become my professional orientation. HAM receivers become and stay my passion. Here are some of my constructions and I apologize that published materials are not prepared better.

HF DC Receivers

First receiver I was ever build for HF was tube receiver without RF amplification called OV2 .It was working good and enable me to listen short waves and HAM bands. After that I build super heterodyne receivers but when I built DC transceiver by W7EL at the beginning of 80's ZL2BKW version I was surprised how good DC receiver can be. With simple dipole antenna for 7MHz I worked 102 DXCC in 1985/86 with not to often work and with output power 1W (BD135 output transistor). After that I made a lot of HF and VHF DC receivers HAM and for professional use, my or other author design. In year 2000 I made presentation in KKE club Belgrade with subject "***Renaissance of HF DC receivers***". Paper material contains 30 pages collected materials about DC receivers with schematics, useful formulas for calculation ,PCBs and complete receivers made or design by author. I apologize that this materials are written on Serbian language but schematics, formulas and PCBs are useful for everyone who is in touch with the DC (direct conversion receiver) subject. If this papers will be interesting for readers I shall translate it to English in future.

RXDC-YU1LM.pdf

Variable Bandwidth XTAL Filter

First paper is published in SPRAT magazine journal of the GQRP Club nr.109. Author is member of GQRP Club number 10091.XTAL Filter is interesting because it is possible to change bandwidth between CW and SSB with input and output impedance close to 50Ohm. For CW bandwidth XTAL filter is very interesting amplitude and phase response. It is close to Gauss response and because of that there is no or low ringing. It is possible to design filters with fixed capacitors. Measurements gave very good agreement with design and very high IP3 in vicinity of 40dBm!!!

XTAL-VAR FILTER-YU1LM.pdf

A Tunable Bandpass Filter for All HF Bands (160m-10m)

Paper is published first in SPRAT magazine journal of the GQRP Club nr.115/2003 20 pages and simulation diagrams. I like very much design and experimenting in design with the 50 Ohm modules. It is possible very easy to check, measure and change design. This is one of the mine very often used and favorite RF brick. Here is complete article with all diagrams which was shorted in Sprat magazine. Design is very simple 4 (6) fixed coils 4 toggle switches 1 double variable and 3 fixed capacitors and you can tune over whole HF band with insertion loss good enough for transmitting purpose max IL=2-3 dB.

BP FILTER HF-YU1LM.pdf

SDR (Software Defined Radio) HF Receivers and Transmitters SSB/CW/AM/FM....based on 74HC4066 Chips from 30 kHz to 70 MHz

SDR is future of radio, maximum flexibility a lot of possibility from the same hardware ,what was very hard achieve with hardware realization now is very easy by software This is series of three parts, three articles are:

Parts 1 contain very simple receiver DR1 without image rejection receiver very simple but good start with the SDR receiving. This receiver was discovery for me and I spent a lot of time in testing and listening with it in different circumstances. It can be realized for the very short time for the one afternoon and it is very cheep. Present of image are not a big disadvantage like in DC direct conversion receivers but something about that later. This receiver can be used as a second or first IF in receivers after crystal filters which very easy reject unwanted image also. As demodulator it is far superior to the all other types common used demodulators in practice. I never didn't measure S/N ratio in HF CW receiver 80 dB before it. DR2 is also very simple and very good I/Q HF receiver frequency are limited to the 30 - 35 MHz with built in components.

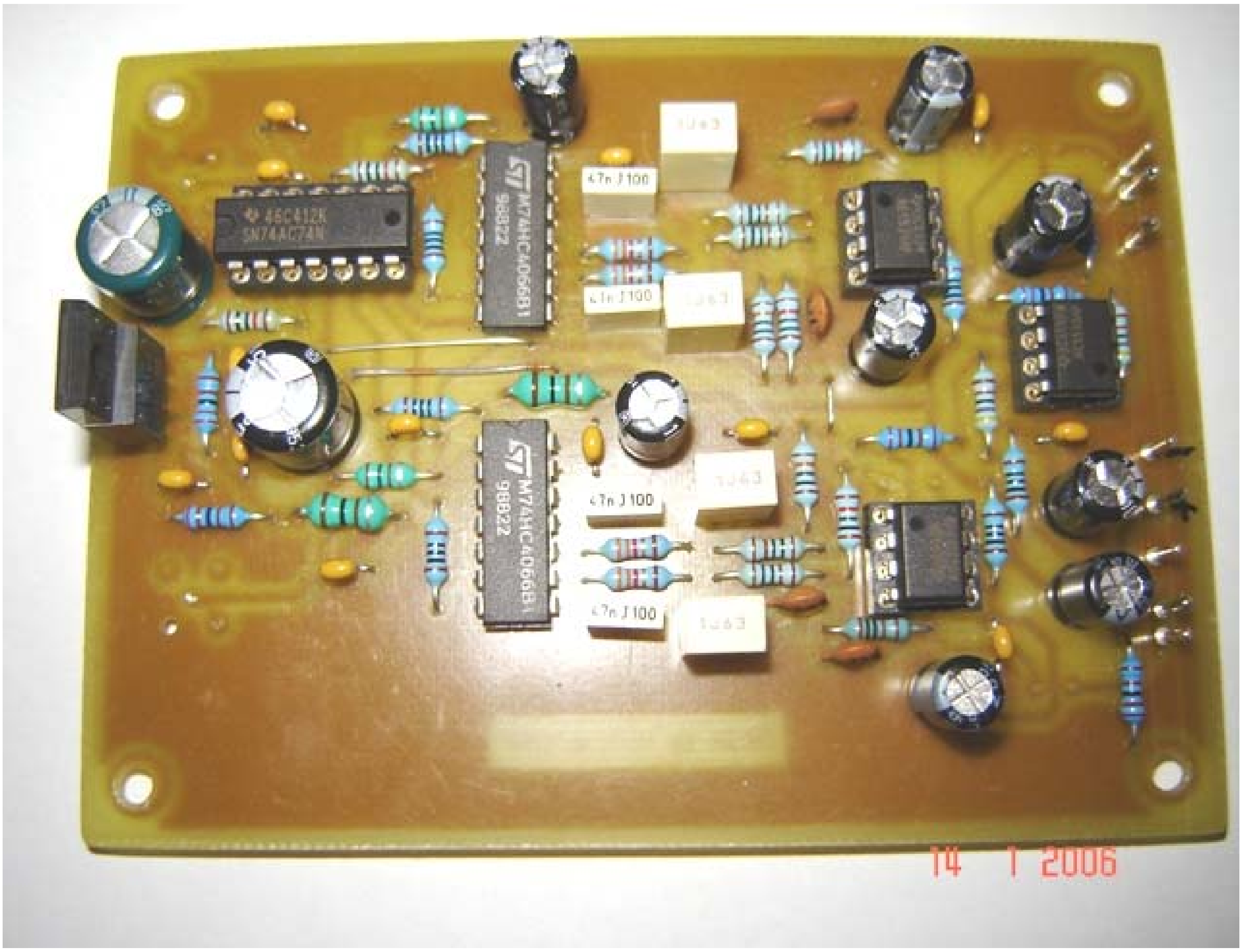
HF SDR RECEIVER CW-SSB-DRM YU1LM.pdf

Part 2 DT1 DSB modulator for frequency from 30 kHz-70MHz with very good linearity and DT2 SSB/CW or any other modulation which can be generate with I/Q signals SDR HF 30 kHz-35 MHz low power transmitter

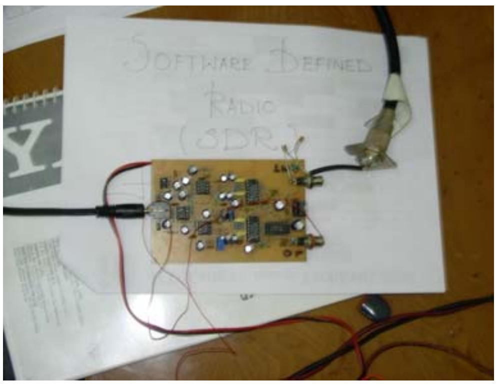
HAM HF SDR TRANSMITTER YU1LM.pdf

Part 3 SDR HF receivers DR1A (Advanced) similar to the DR1 but with improved specifications the same situation is with DR2A and improved DR2 and transmitter DT2A. Practical experience and answers on questions.

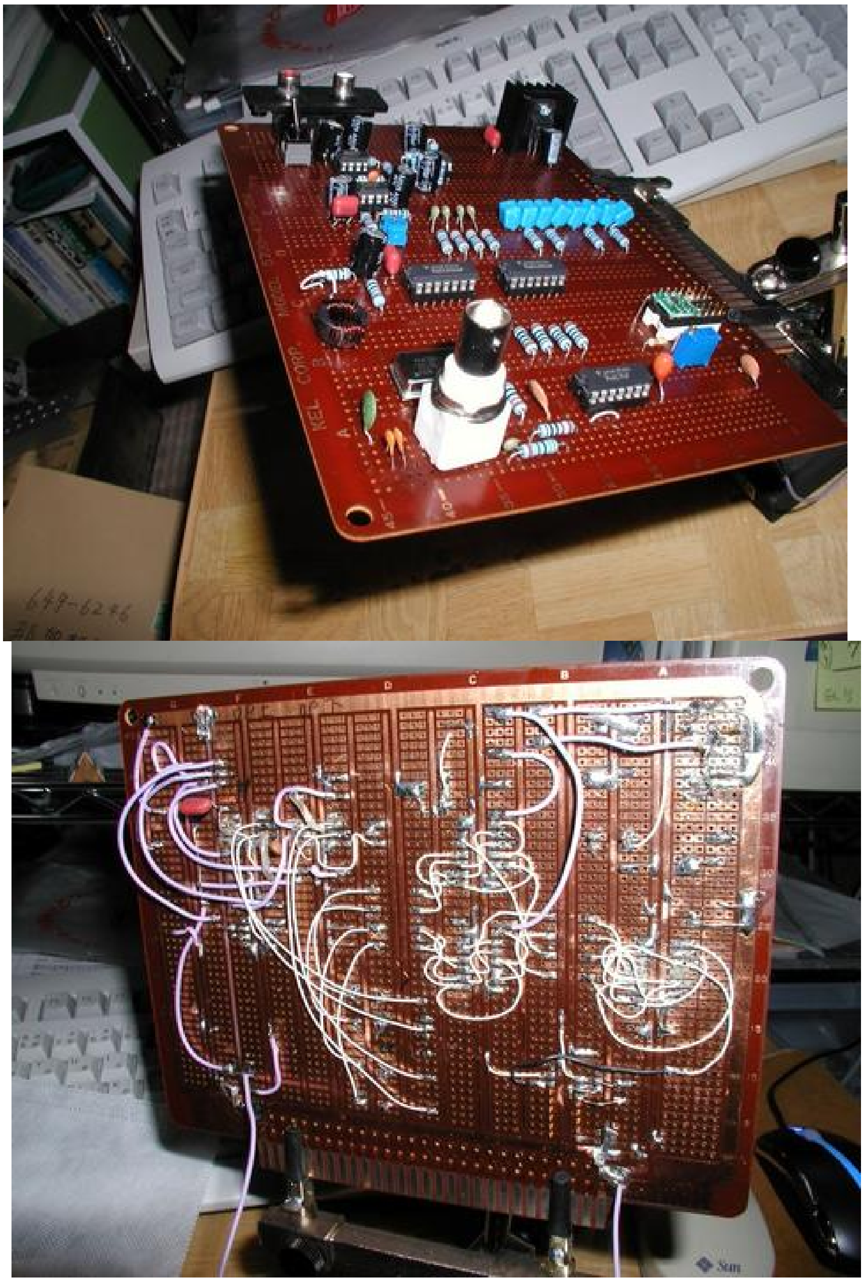
FINAL HF SDR RECEIVERS, TRANSMITTER YU1LM.pdf



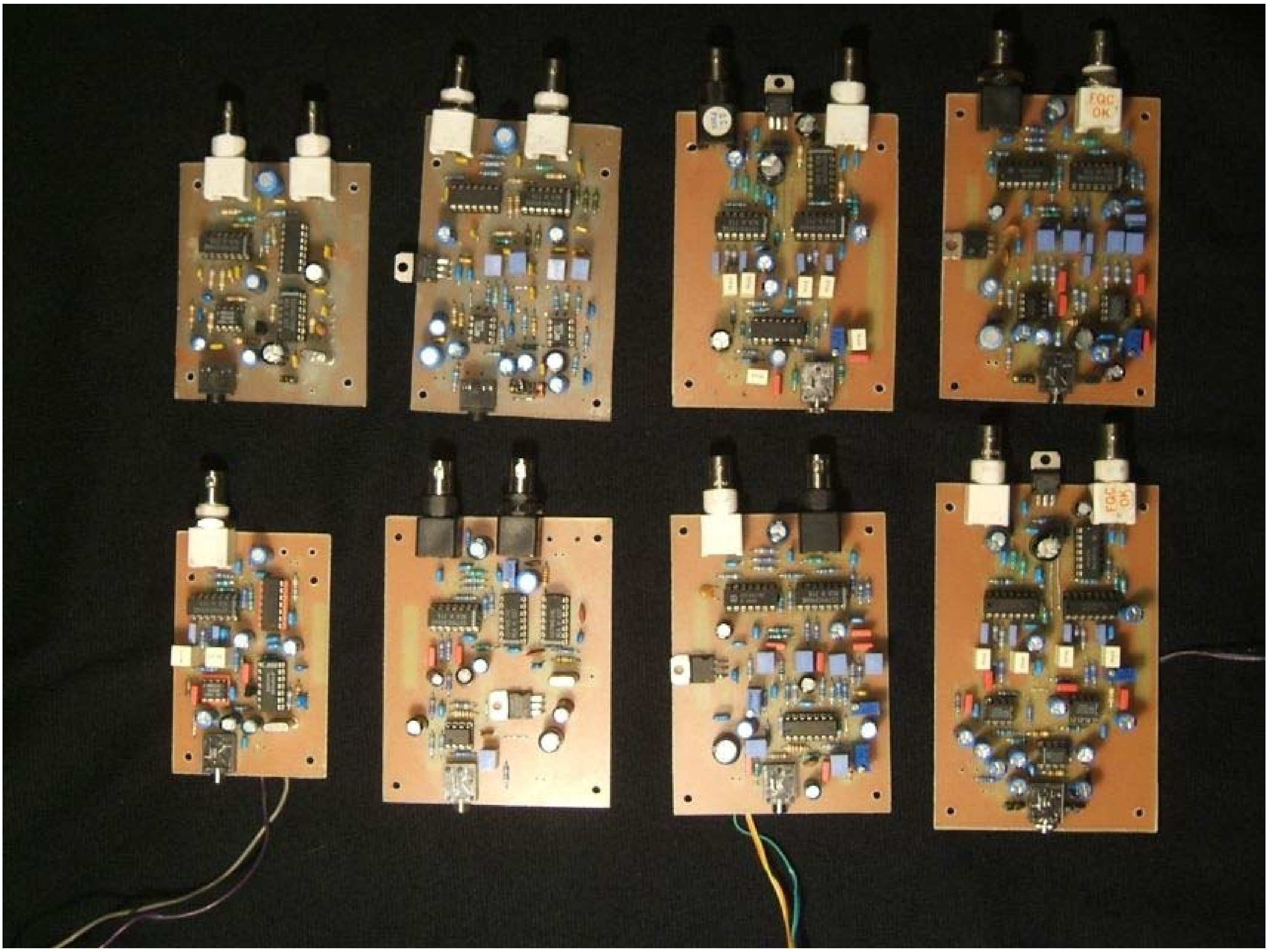
SDR HF receiver DR2A first version built by Batko YU1OL



SDR receiver DR2A built by Rahul VU3WJM



SDR receiver DR2A built on proto-board by Tuji JH3JMT



SDR projects built by author Tasa YU1LM/QRP

Band pass filters for Top band -160 m to improve selectivity and receiver IMD specifications

Band pass for 160 m-YU1LM.pdf (new version 04.04.2006)

Band pass filter for 160 m built by Michel ON7EH

SDR HF I/Q S/H (Sample and Hold) Receiver - DR3X from 30 kHz-35 MHz for 3 bands harmonically related with 1(one) XTAL

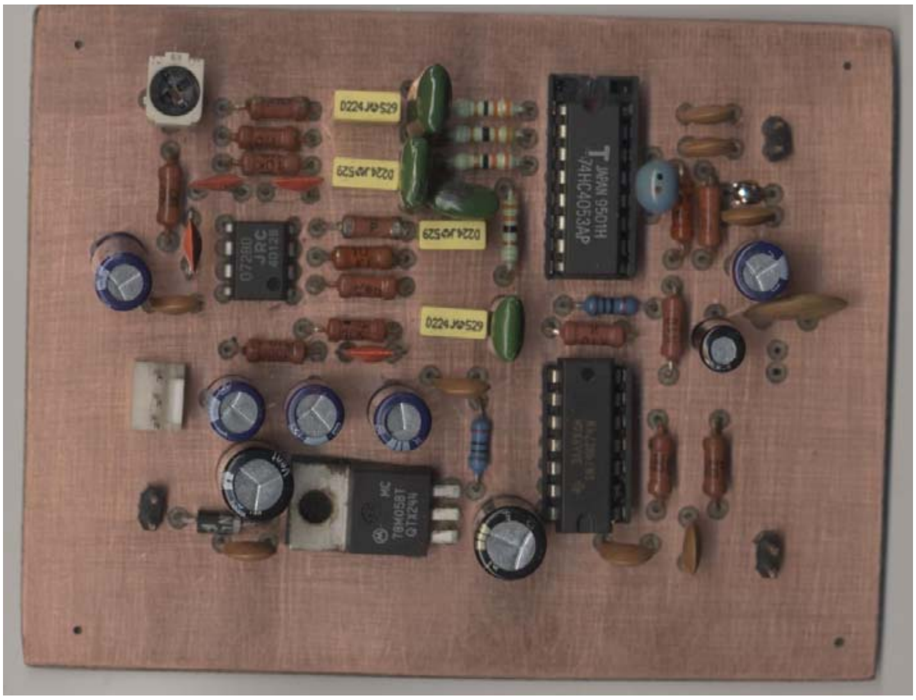
I made local presentation of mine SDR projects Audience was very surprised with very good received /demodulated signal quality, crisp and clear sound like HI-FI (high fidelity) not common for the most commercial RIGs.They were surprised with design simplicity also. SDR possibilities such as adjustable selectivity, noise reduction, NB noise blanker; waterfall, wide and narrow monitoring at the same time … were discovery for most of them. Local HAMs first excitements with new SDR techniques ware replaced with some kind of disappointment because most HAMs like to tune LO (local oscillator) all over the working band .They aren't satisfied with +/- 20 KHz with fixed LO. I proceeded with mine SDR experiments and here is my solution to improve possibility of simple HF SDR receivers. DR3X receiver is design now with 74HC4053 IC It enable 3 band receiving harmonically related with single oscillator. Of course all 3 bands receiving is without any input filter and realization is with an classic size components.

DR3X HF SDR RECEIVER-YU1LM.pdf

SDR HF I/Q S/H (Sample and Hold) Receiver - DR2B from 30 kHz- 35 MHz with external LO (local oscillator)

DR2B receiver PCB is product from DR3X receiver .Here is one of 3 possible connection for DR3X . It is connection for external local oscillator with new PCB, it is very small compared to the original DR3X PCB .This receiver is similar very much to the previously published DR2 but even simpler.

DR2B HF SDR RECEIVER-YU1LM.pdf

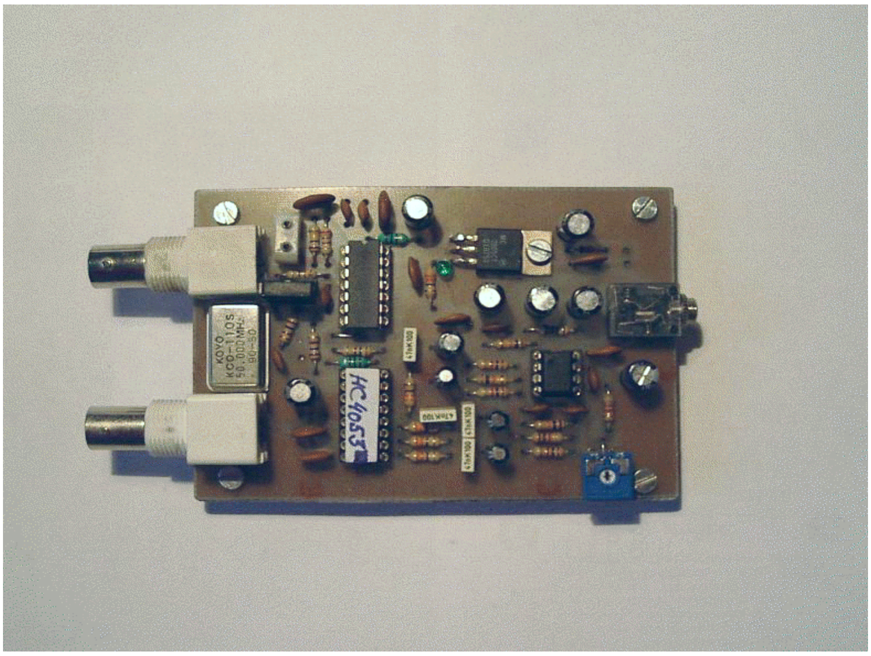


DR2B SDR receiver built by Ramaz 4L7AR

SDR HF I/Q S/H (Sample and Hold) Monoband Receiver - DR2C from 30 kHz- 50 MHz with LO at working frequency

After I made DR3X I decided to try and enable mono band SDR receiving from 30 kHz to 50 MHz with LO working at receiving frequency. Here is my SDR RX design realized with 74HC4053 IC also. This design is good challenge to be build inside existing RIGs as parallel IF and demodulator. This solution is giving advantage of use SDR signal processing through SB (sound blaster) card in PC . Better SB card give better possibility and better audio quality.

Monoband SDR HF receiver DR2C-YU1LM.pdf

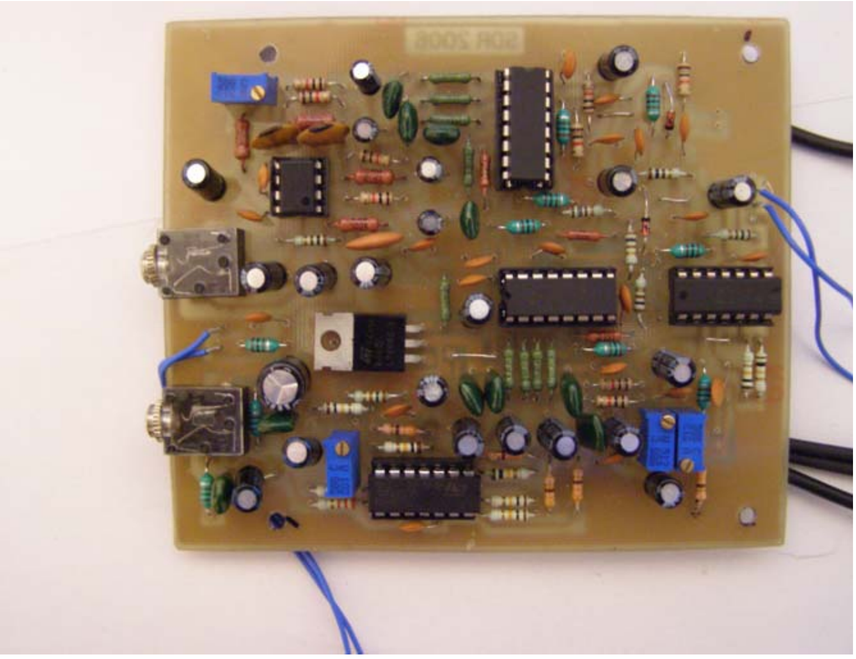


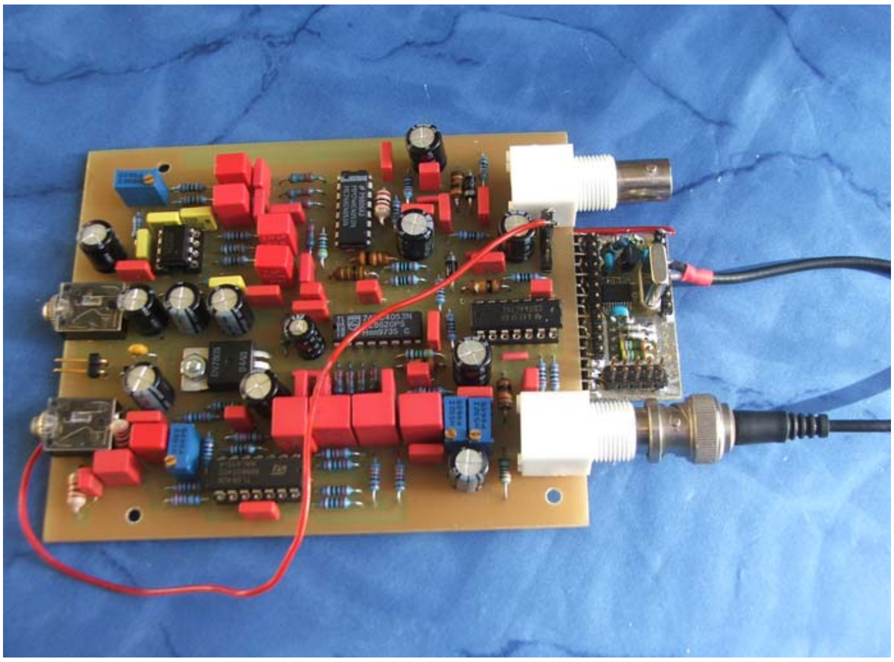
First version of DR2C built by Miki YU1KM

Low power SDR HF I/Q S/H (Sample and Hold) transceiver CW,SSB...- ADTRX1 from 30 kHz-35 MHz with external LO-part 1

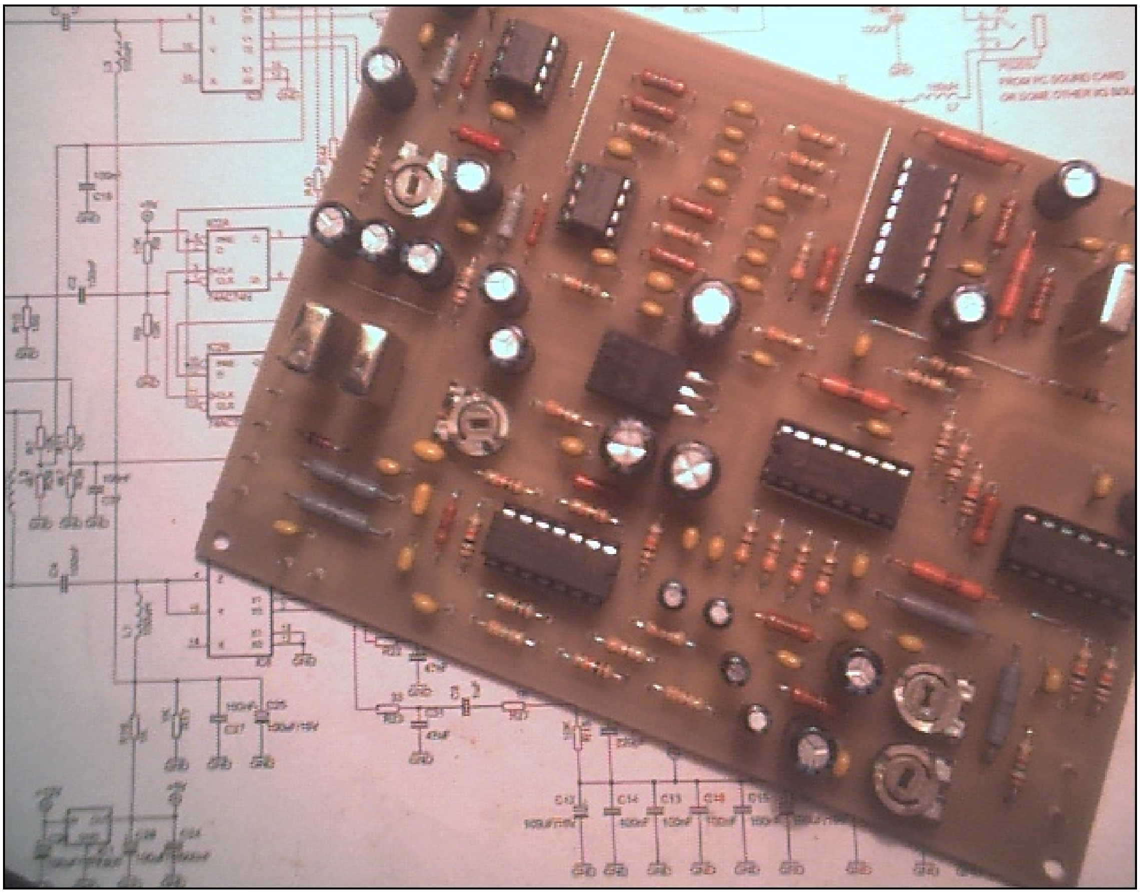
HF SDR transceiver called ADTRX1 (analog + digital) is compilation of the results and previously published designs. ADTRX1 is working to the 35 MHz and it is a very simple and promising design all with classical size components. It is very good introduction in to the new SDR technique of the HF transceiver design. Most of demanding specification for HF transceivers are in software now, not in hardware like in classic HF transceiver design. Part 1 is giving description main ADTRX1 board, results and basic connections

HF SDR transceiver ADTRX1-YU1LM part1.pdf

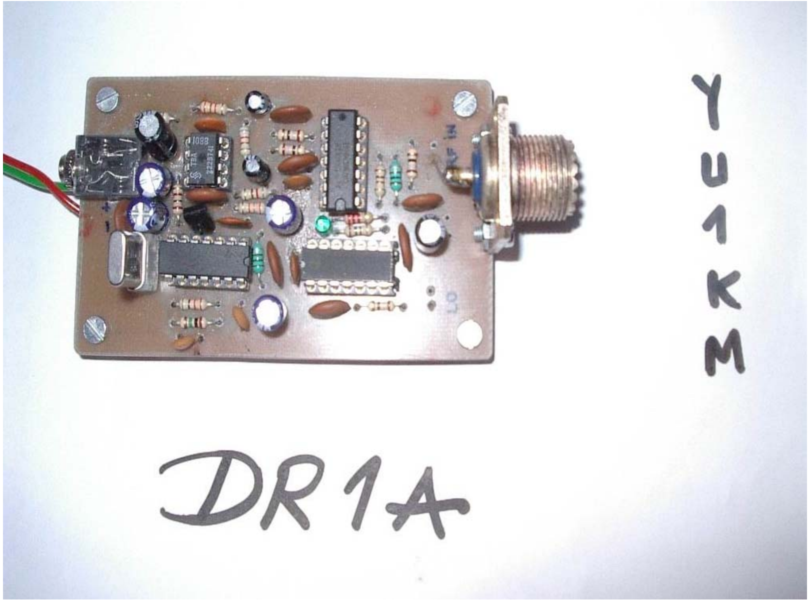




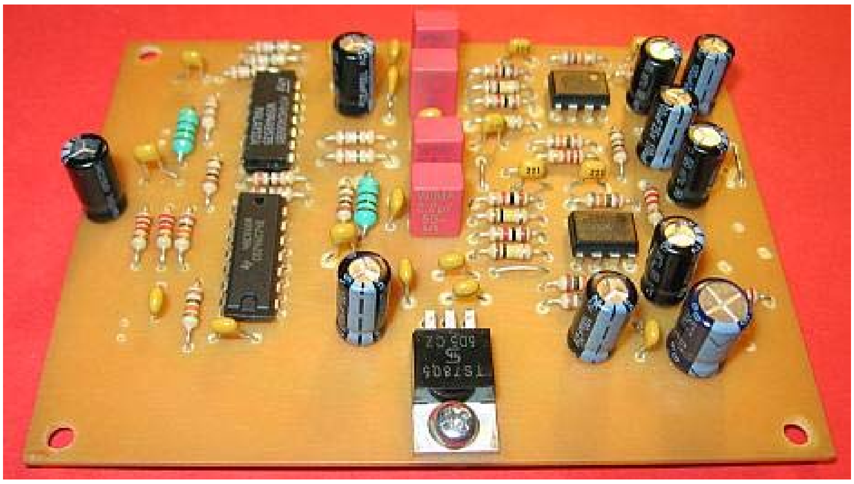
ADTRX1 SDR Transceivers built by Andrey US5EQQ and by Wolfgang DK2CQ



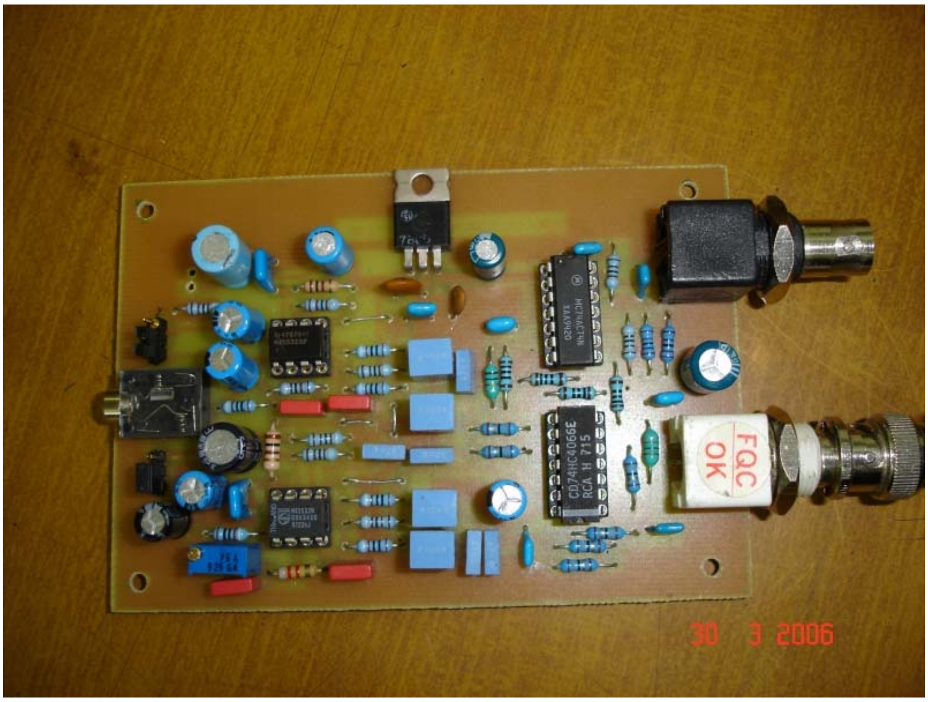
ADTRX1-V1 SDR transceiver built by Gena UA6XW/9 with his PCB version



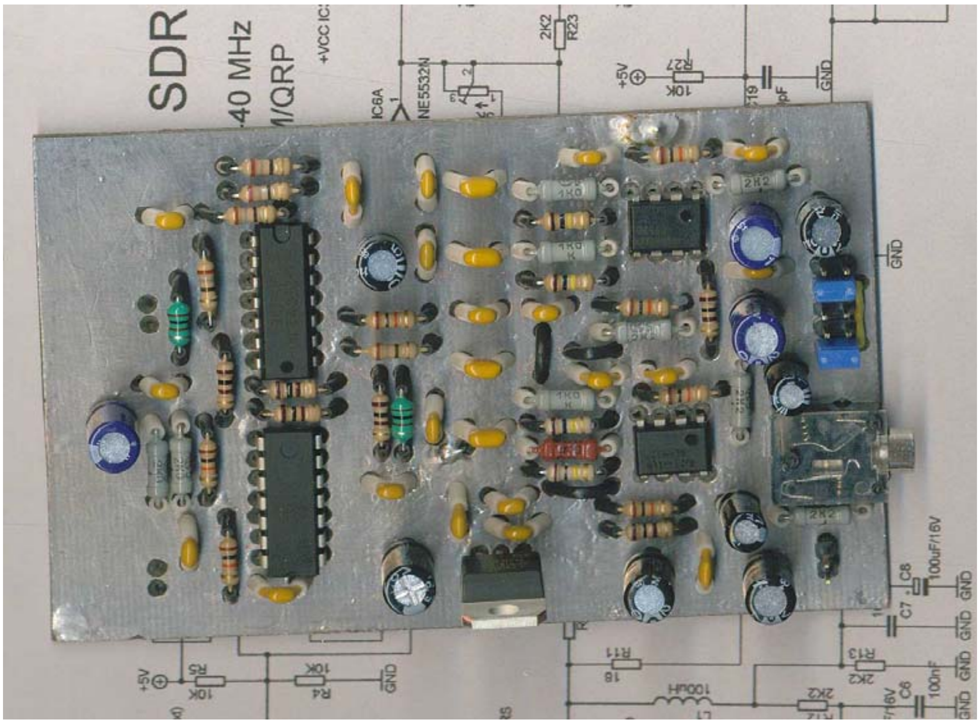
SDR receivers DR1A and DR2 built by Miki YU1KM



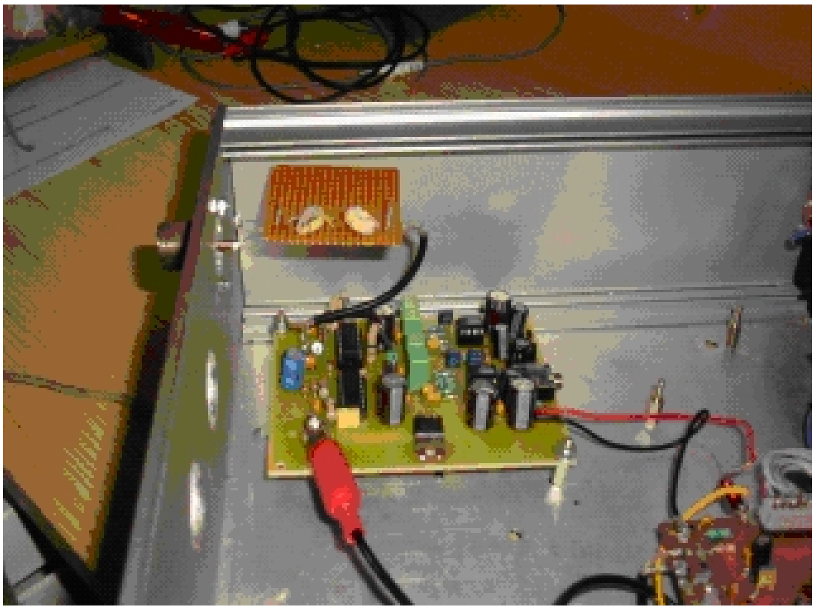
SDR receiver DR2 built by Volker SM5ZBS



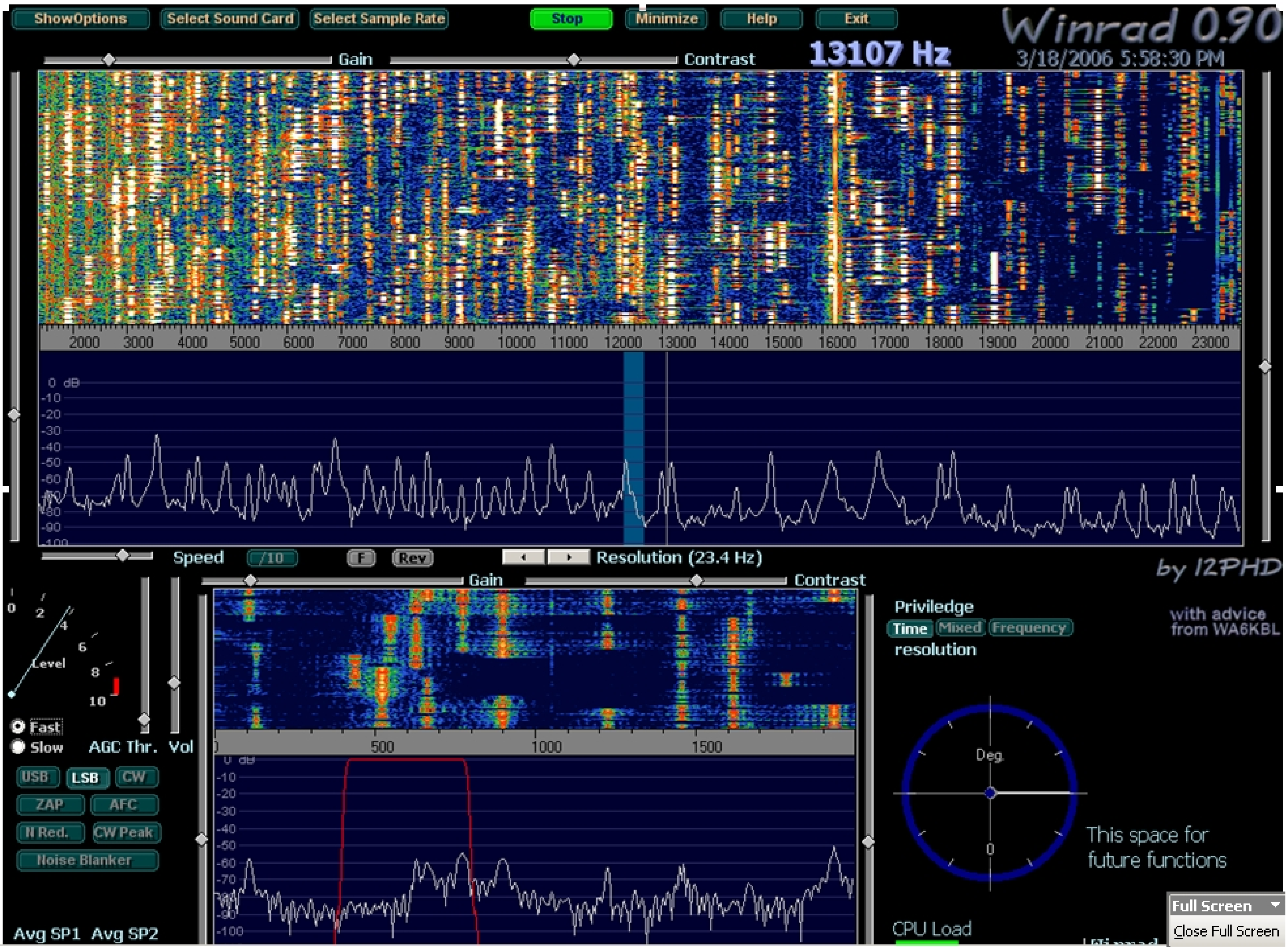
DR2 SDR Receiver soldered by my sons Stefan, Andrej and Bojan



DR2 SDR receiver built by UN7DAQ



DR2 SDR receiver built by Jean F1BEM



WINRAD screen shot from YU1LM/QRP DR2A receiver on 7 MHz in RDA contest 2006

PowerSDR screen shot from YU1LM/QRP DR2A receiver on 7 MHz in WW CW contest 2006

Low power SDR HF I/Q S/H (Sample and Hold) transceiver CW,SSB..- ADTRX1 from 30 kHz- 35 MHz with external LO-control board B1 and B2 -part 2

ADTRX1 SDR transceiver part 2 . In this article I am describing different possibilities with new control hardware boards B1 and B2. I made PCB corrections for ADTRX1 and new ADTRX1-1 version with 2 AF gain position like it is done in the SDR receivers DR2 ,DR2A.. . The receiving path in ADTRX1 is going always through the SB card and for transmission I am describing here 3 ways how to perform it. First way is completely digital with using SB card only , second way is completely analog with built in hardware and third way is mixture solution partly digital partly analog hardware. In the moment when I started design and experimenting with control boards there ware not freeware software for transmission. Now we have few software and situation is a quite different. The readers can decide individually how to do transmission.

HF SDR transceiver ADTRX1-YU1LM part2.pdf

SDR HF I/Q S/H (Sample and Hold) receiver- DR2D from 30 kHz- 50 MHz

The DR2-D is DR2B, DR3X modification . The DR2D is I/Q HF SDR receiver with possibility to work with 2 times higher LO frequency. This design is my attempt to help to all SDR fans who are using AD9850 DDS LO. With 60 MHz output LO frequency it is easy now to receive 30 MHz at RX input. This design is making small phase error which we can compensate in software or by hardware adjustment. Optimum design is possible for input frequencies lower than 15 MHz where is RX dynamic much important performance.

DR2-D HF SDR Receiver YU1LM.pdf

SDR HF I/Q S/H (Sample and Hold) receiver - DR2-2 from 30 kHz- 35 MHz

DR2-2 is DR2 modification .The DR2D is HF SDR receiver **without any RF parts no coils only R,C** and cheap ICs but with outstanding performances. This design is my a small attempt to enable everyone to build very good HF receiver without any knowledge, measuring instruments except DMM (digital multi meter) only with small skill for soldering. New design is also design simplification compared to the original one.

DR2-2 HF SDR Receiver YU1LM.pdf

SDR HF I/Q S/H (Sample and Hold) receiver - DR2E from 30 kHz- 35 MHz

DR2E is DR2 modification. DR2E is my attempt to improve previously published and realized DR2 design and overall specifications. DR2E has a new post detector amplifier realized as instrumental OP AMP.

DR2E HF SDR Receiver YU1LM.pdf

Band pass filter with low insertion loss IL for 2 m

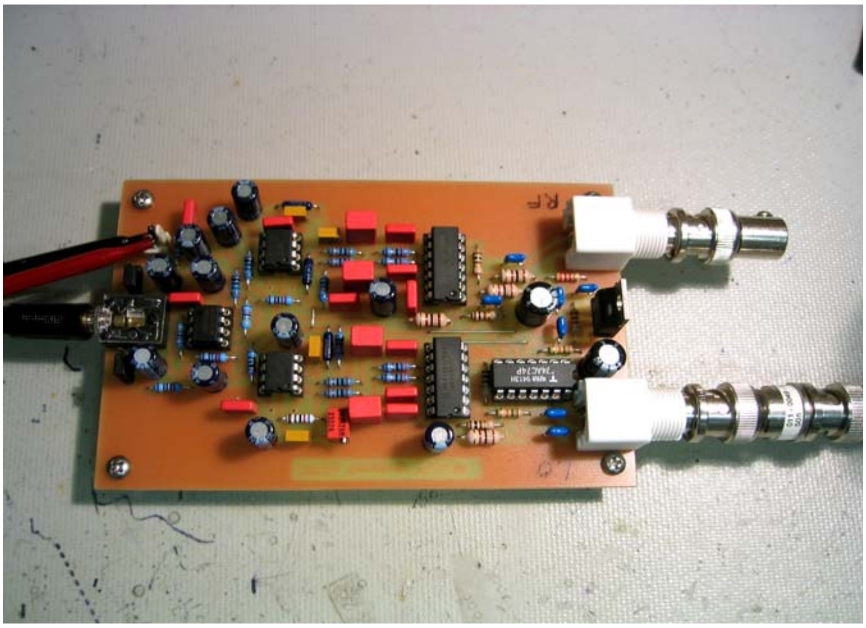
This is input band pass filter for mine 144 MHz SDR receiver. It has a good selectivity and insertion loss is 0.65 dB max. Realization is simple ,very easy and repetitive.

Band pass filter for 2m-YU1LM.pdf

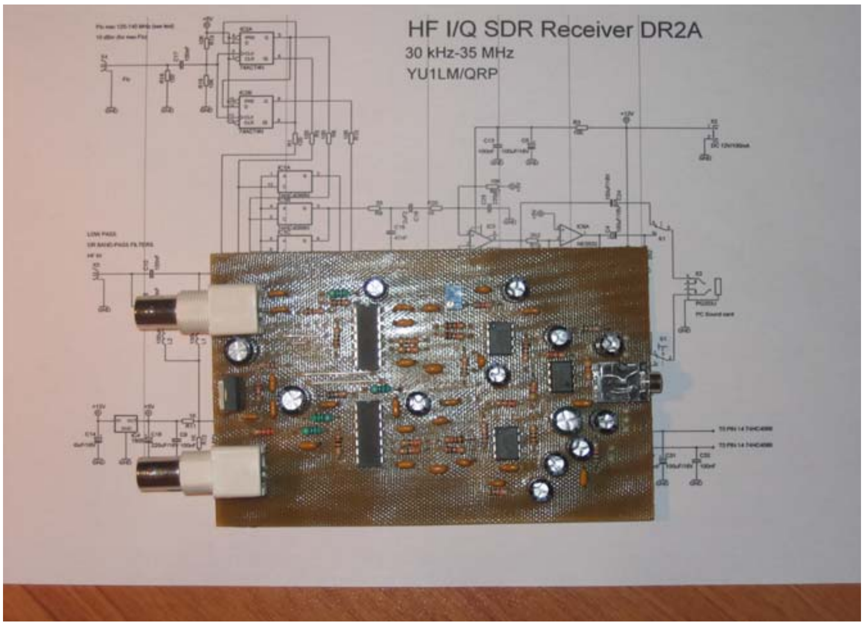
Additional measurements on HF SDR S/H receiver DR2A with & Norbert DG1KPN

I made a lot measurements on my SDR and other designs and they consume a lot of mine free time specially in attempt to improve some performances. Of course it is possible always to do some new measurements. OM Norbert DG1KPN made some new one and we exchange few E-mails to improve DR2A receiver performances if it is possible .SDR S/H receiver DR2A has the best specifications from all my SDR S/H receivers.

DR2A additional measurements YU1LM&DG1KPN.pdf



DR2A SDR receiver built by Norbert DK1KPN



DR2A SDR receiver built by Sergej RA3AJK

Correction for YU1LM previously published SDR designs

I made a lot of designs and I always try to do best from my side. I made some mistakes because PCB and schematics are not done one from other. I made this two activity separately because PCB design in CAD not satisfying me with results which it made automatically. This is reason why I hadn't always good correspondence between each other. Also sometimes I made some correction on my realized PCBs before publishing and I accidentally made some errors trying to do design better. I have ask all readers and homebrew apologize for inconveniences and ask all to help me and other homebrew fans to find them. I made check few times but mistakes obey Murphy low and it is hard to prevent them.

YU1LM SDR designs correction- November 2006.pdf

AF all pass quadrature networks- old technique effectively revised

During ADTRX1 SDR transceiver design I went back to the past to the my previously designs. Missing SDR free software for transmission at my SDR transceiver design start I try to solved with some classic I/Q AF design with help a new free software. The results are very curious for HAMs who want to make direct phasing type SSB transmitter. Here we have a lot different realization and simulation for normal AF bandwidth or SDR frequencies to the 20 kHz. This design is included as part of the control board B2A2.

AF all pass networks -YUAF ALL-PASS NETWORK-YU1LM.pdf1LM.pdf

HF/VHF/UHF SDR receivers with LO at receiving frequency

Many HAM like to try new SDR technique at higher VHF/UHF frequencies. This task direct receiving is not so easy except to use standard super-heterodyne RX with HF IF where we can use new SDR technique. This design is with double balanced diode mixer as demodulator. First part describe some theoretical problems and I publish few version HF.VHF/UHF SDR receivers without image rejection.

VHF/UHF SDR receivers-part1-YU1LM.pdf

Band pass filters with low/moderate insertion losses IL for 6 m

This article describes 3 types of input band pass filters for 50 MHz receiver/transmitter use . They have good/moderate/high selectivity and insertion losses in range from 0.65 dB to 2.3 dB max. Realization is simple ,very easy and repetitive.

Band pass filter for 6m-YU1LM.pdf

Universal HF/VHF crystal oscillator with 4 crystal quartz switching possibility

This is my attempt to make low noise switching universal oscillator for use with mine HF/VHF SDR projects or high frequency reference oscillator for DDS IC like AD9850/AD9851...... Realization is simple ,very easy and repetitive and I attached a lot of simulation diagrams.

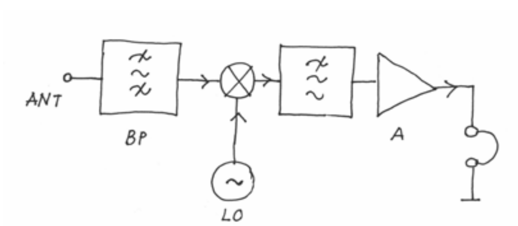
HF-VHF universal oscillator-YU1LM.pdf

RENESANSA DC (Direktnih) PRIJEMNIKA

Dipl ing. Tasić Siniša YU1LM/QRP

O temi direktnih prijemnika u daljem tekstu DC (direct conversion) u literaturi na našem jeziku ima vrlo malo članaka a posebno onih koji se odnose na najnovija dostignu}a na tom polju . Stariji konstruktori se sa nostalgijom sećaju prijemnika tipa 0V1,1V2 i sličnih koji su se mogli naći po literaturi i koji su služili da se "izađe" na opseg . Prijemnici su koristili superregenerativni proces i na taj način vršili detekciju CW i SSB signala. Ovaj tip prijemnika ima relativno dobru osetljivost ali ne zadovoljava ozbiljnije zahteve koji se postavljaju pred savremeni prijemnik . Na KT opsezima prijemnik treba posebno da ima veliku dinamiku , prijemnik treba da "istrpi " na svom ulazu velikog broja jakih signala bez generisanja nepostojećih signala na svom izlazu . Ovaj tip DC prijemnika se ne razmatra iako i on ima primenu u alarmima za kola i stanove zbog svoje jednostavnosti malih dimenzija i potrošnje . U ovom članku su obrađeni DC prijemnici koji imaju izdvojeni oscilator (VFO ili BFO) i mešac vidi blok semu na slici 1 i to:

1**. DC prijemnici koji imaju audio imidž(image)**
2. DC prijemnici sa potisnutim au imidžom korišćenjem audio mreža za pomeranje faze
3. DC prijemnici sa potiskivanjem audio imidža po trećoj Weaver –ovoj metodi



Slika 1 Blok {ema DC prijemnika

Pre nego što se posvetimo DC prijemnicima izvršit ćemo kratko upoređenje DC i superheterodinskih prijemnika i izneti prednosti i nedostatke jednih i drugih .

Superheterodinski prijemnici su :

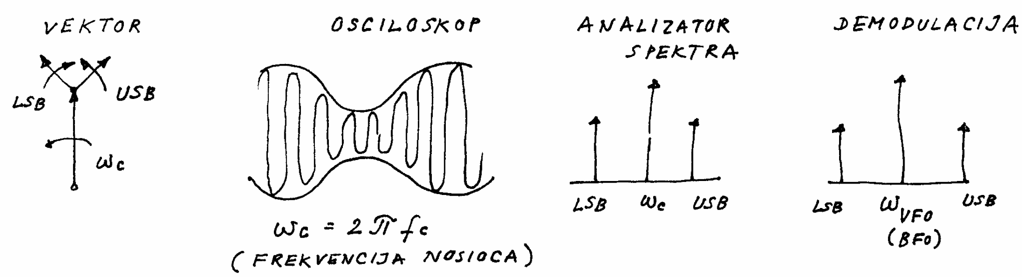
-komplikovaniji po strukturi i izuzetno komplikovani za podešavanje i generalno su skupi (posebno razni kristalni IF filteri)
-imaju probleme sa simetričnom frekvencijom , izborom međufrekvencije i plana mešanja
-imaju probleme sa sintetizatorima (višestruke petlje PLL) , faznim šumom i špurijusima sinteze
-glavni problemi pri gradnji nastaju zbog RF problema

-glavna prednost, moguće je postići pažljivim dizajnom i izborom komponeneta odlične karakeristike ali to je najčešće nedostupno većini amatera bilo zbog cene , instrumenata ili potrebnog RF iskustva iz raznih oblasti.

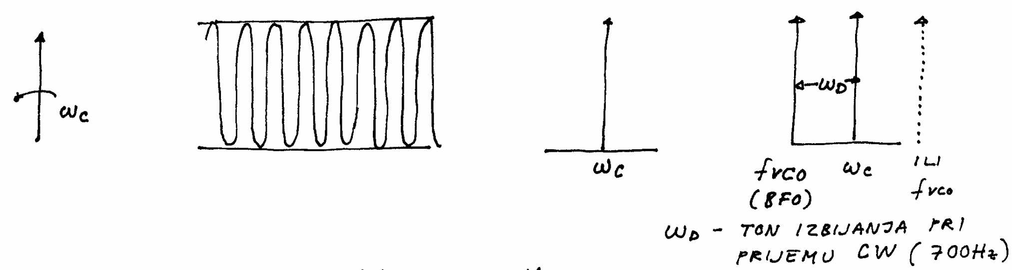
DC prijemnici sa druge strane su:

-generalno značajno jeftiniji i prostiji , to se posebno odnosi na DC prijemnike pod 1
-nemaju problema sa mešanjem i faznim šumom kao superheterodinski prijemnici

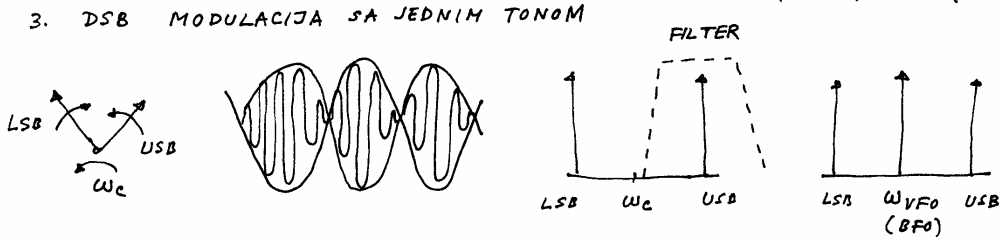
1. AM MODULACIJA



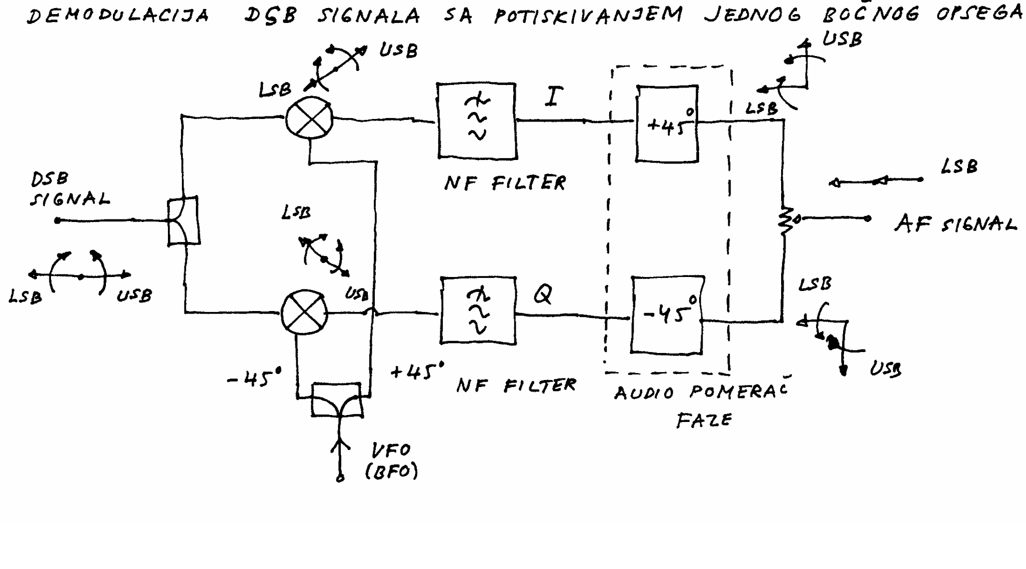
2. CW ILI SSB MODULACIJA SA JEDNIM TEST TONOM



3. DSB MODULACIJA SA JEDNIM TONOM



DEMODULACIJA DSB SIGNALA SA POTISKIVANJEM JEDNOG BOČNOG OPSEGA



Slika 2 Teorijsko objašnjenje rada DC prijemnika

-potiskivanje audio imidža je teško postići kao kod superhetarodinskih prijemnika
-moguće je maksimalno koristiti prednosti digitalne elektronike i DSP (digitalnog signal procesinga)
-DC prijemnici su osetljivi na jake AM signale (to se posebno čuje na 7MHz kao BCI muzika u pozadini koju je teško eliminisati) ovaj problem ne postoji kod superheterodinskih prijemnika
-***vrhunski DC prijemnik nije jednostavan a ni prost*** . Opcija DC prijemnika za više opsega je izuzetno komplikovana i teško ostvariva . Glavna prednost DC prijemnika je da je to NF tehnika pa je potrebno relativno skromno RF iskustvo i prosti instrumenti (bolji AVO metar sa merenjem kapaciteta i pojačanja tranzistora eventualno osciloskop i RF generator)
-slušanjem , a to je subjektivan kriterijum , DC prijemnici ostavljaju utisak HI-FI-ja u odnosu na najveći broj superheterodinskih prijemnika .

Da bi se bolje razumeli problemi konstrukcije a posebno razlozi za pomeranje faze kod DC prijemnika pod 2 data je slika 2 koje pokazuju proces modulacije i demodulacije AM , DSB , CW i SSB signala sa vektorima . Slike daju vezu sa slikama na osciloskopu i analizatoru spektra a ne uzimaju u obzir komplikovani matematički aparat . Objašnjenja rada DC prijemnika i demodulacije sa Hilbert-ovom transformacijom ,sa pozitivnim i negativnim frekvencijama često su vrlo nerazumljiva i teško shvatljiva čak i ljudima iz elektro struke .

Ideja vodilja ove preyentacije i članka je da se ponude konstruktorima razna rešenja pojedinih blokova i sklopova koja bi bili zasebni moduli tako da bi konstruktor mogao da eksperimentiše i isproba razne verzije DC prijemnika . Ovakav način gradnje omogućava proveru raznih rešenja i njihovih mane i prednosti polazeći od materijala koji je dostupan svakom pojedincu . Gradnjom se može steći relevantno iskustvo iz oblasti DC prijemnika i eventualno neku konstrukciju nadograditi u CW/SSB primopredajnik . Autor se ograđuje od eventualnih grešaka u šemama jer iako je probao većinu sklopova nije sva koja su data . Analize koje su urađene u CAD programima pokazuju da su pojedini autori namerno ili iz neznanja davali pogrešne vrednosti pojedinih elemenata ili se radi o štamparskim greškama . Autor je pokušao da sve eventualno uočene greške ispravi . Pored toga autor se nije bavio problemima pravljenja VFO ili BFO jer je to tema sama za sebe takođe se nije upuštao previš{e u ulazne filtre već je dao predlog prostih ili ralativno lako ostvarivih rešenja.

DC prijemnici su kako je rečeno prosti ali imaju i neke probleme o kojima se mora voditi računa pri projektovanju i realizaciji pojedinih sklopova a koji se mogu svrstati u sledeće kategorije a veoma precizno ih je opisao N.Hamilton G4TXG u časopisu Radio Communication 4/1991:

-RF brujanje (hum) , pojava potiče od toga što 50 HZ moduliše lokalni oscilator sa 50 Hz . Bočne komponente od 50 Hz se čuju u prijemu kao brujanje. 50Hz se i reemituje sa linija za napajanje i prima preko antene . O ovom problemu je dosta pisano i od strane ARRL-a u Handbook-u . Rešenje ovakvog problema je da lokalni oscilator ili BFO moraju biti oklopljeni, najprostije,najbrže i najlakše rešenje je kutija od vitroplasta koja se lako obrađuje i lako lemi.

-AM detekcija , problem za koji je rečeno da postoji samo kod DC prijemnika . Pojava se dešava na mešačima zbog nedovoljne linearnosti istih kada oni rade kao AM detektori a demodulisani signal se zatim pojačava sa NF delom prijemnika . Ova pojava je prisutna i kod superheterodinskih prjemnika ali se sa MF kristalnim filterom eliminiše jer se pojačava MF . Ova pojava traži da postoji dovoljna selektivnost pre mešača kako bi se eliminisali ili smanjili signali van primanog opsega ili da se koriste prekidački mešači sa digitalnim kolima 4066 , 74CBT3253 ili sličnim . Digitalni prekidački meš{ači omoguć}avaju da na mešač priključe antena bez filtara a da još nešto korisno čuje na izlazu iz prijemnika , probajte ovaj test sa nekim drugim tipom mešača. Ova karakteristika DC prijemnika data je sa signalom obično u mV na ulazu u prijemnik i koji daje signal na nivou šuma . Dobre, vrednosti za DC prijemnik su reda 5-10mV ili signali reda S9 plus 50-60 dB na ulazu u mešača . Rešenje ovog problema je korišćenje što linearnijih mešača . Mešači sa dve antiparalelne diode sa LO na 1 / 2 fs imaju najbolje razultate kod. diodnih mešača ali ovaj tip detektora nije razmatran zbog njegovih drugih slabosti

-NF brujanje (hum) je posledica što 50 Hz direktno ulazi u NF delove prijemnika . Raspored pojačanja DC prijemnika je sasvim različit od onog kod superheterodinskog , pojačanja reda 100 dB su sasvim normalna i potrebna . Rešenje za ovaj problem je da se koriste oklopljene kutije i širmovani (oklopljeni) kablovi.

-Mikrofonija pojava koja može biti NF ili RF porekla. NF mikrofonija se rešava dobrom mehaničkom konstrukcijom gumenim odstojnicima ili slično . RF mikrofonija je posledica curenja oscilatora za detekciju (LO , BFO) na ulaz mešača. Signal se zatim reflektuje od ulaznog filtra , mehaničke promene menjaju fazu reflektovanog signala i daju NF siganl na izlazu mešača i debalansiraju isti . Rešenje je korišćenje kvalitetnih komponente i koje su zalivene , pre svega kalemovi u diplekseru na izlazu mešača.

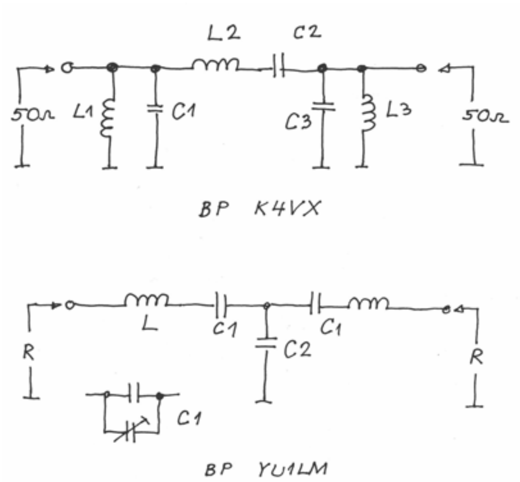
-NF petlje i oscilovanje , javljaju se najčešće kada izlazni NF pojačavač pobuđuje zvučnik .Velike struje koje su potrebne za NF pojačavač ako isti daje značajnu snagu , promene napona napajanja se detektuju u stepenima malih nivoa i pojačavaju sami od sebe i ako je nepovoljan raspored, signal se pojačava sam od sebe do klipovanja . Sve je to neprijatno za bilo kakvo slušanje. Rešenje ovoga problema je poštovanje pravila NF tehnike o zvezdastom rasporedu masa ako je mogu}e i korišćenje RC filtara na napajanje svakog modula , stepena i na taj način sprečavanje “kuplovanje” preko napona napajanja.

Bitni sklopovi DC prijemnika o kojima se posebno govori pre nego nego počnemo da govorimo o gore navedenim tipovima DC prijemnika su :

1. **Ulazna kola**
2. **Mešači**
3. **Diplekseri na izlazu mešača**
4. **NF pojačavač na izlazu dipeksera mešača**
5. **Delitelji i pomerači signala i LO u fazi i kvadraturi (za 90 stepeni)**
6. **Pomerači faze audio signala za 90 stepeni**

1.Ulazna kola na primanoj frekvenciji treba da obezbede dovoljnu selektivnost van primanog opsega . Autor ovog članka je pobornik ulaznih kola bez izvoda na kalemovima . Realizacija i podešavanje filtera sa kalemovima sa izvodima bez odgovaraju}ih instrumenata je izuzetno težak zadatak , posebno za nedovoljno iskusne konstruktore . Često se kao posledica loše podešenih ulaznih kola javljaju razni problemi: loša osetljivost ili AM detekcija što dovodi do bezrazložnog razočaranja u DC prijemnike ili konstrukcije istih . Dobri a relativno prosti filteri su one koje je dao L.Gordon K4VX u QST-u broj 09/1988 . Izgled filtera je dat na slici 3 a vrednosti elemenata sa karakteristikama dati su u tabeli ispod:

band	slabljenja na ostalim opsezima u dB				
(MHz)	3,5	7	14	21	28
3,5	<0,5	29	50	65	68
7	30	<0,5	32	41	49
14	56	32	<0,5	16	40
21	63	44	8	<0.5	15



slika 3 Filteri propusnici opsega

Band	C1/C3 (pF)	C2 (pF)	L1/L3 (uH)	L2 (uH)	centar f MHz
1.8	4000	400	2,2	22	1,75
3.5	2000	200	1,1	11	3,4
7	1000	100	0,55	5,5	6,8
14	500	50	0,28	2,8	13,6
21	330	33	0.18	1,8	20,7
28	250	25	0,14	1,4	27,4

Dobra osobina ove K4VX realizacije je velika nekritičnost na vrednosti elemenata što nije karakteristika za zanemarivanje . Inače filteri su inicijalno predviđeni da stoje na izlazu primopredajnika od 100W i da spreče smetnje , pre svega širokopojasnim šumom , izlaznih tranzistirskih pojačavača na drugim opsezima u Multi-multi Contest timovima.
Sličan filter koji daje nešto bolju selektivnost ali koji traži da u filterima nalaze trimer kondenzatori i koji je neštto komplikovaniji za podešavanje .Šema filtra je data na slici 3 . Autor je isti objavio u časopisu CQ QRP 6/7 1985 evo formula za njegovo izračunavanje gde su:

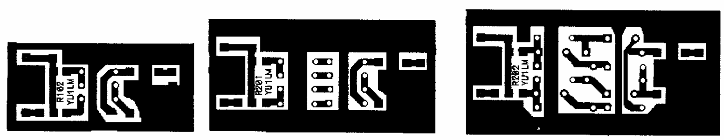
R-ulazno izlazna impedansa (u našem sličaju 50 Ohm-a)
f1-gornja granićna frekvencija filtera (u Hz)
f2-donja granična frekvencija filtera(u Hz)

L= R / (2* (f2 - f1))
C1= (f2 - f1) /2 * f2 * f2 * R
C2=1 / (f1 + f2) * R
L se dobijaju u (H) a C u (F)
Filtere treba projektovati tako da propusni opseg B= f1 – f2 bude optimalno 10 % – 25 % od f1 . Ako se pažljivo gledaju formule za izračunavanje filtera vidi se da se L ne menja zavisno od frekvencije već da zavisi isključivo od B. Problemi u realizaciji filtara sa malih B na višim frekvencijama sada postaju jasniji jer je izuzetno teško realizovati velike induktinosti sa dobrim Q faktorom na visokim frekvencijama.I sa skoro idealnim induktivnostima i kapacitivnostima , Q veoma veliko , gubici filltra rastu ako se B smanjuje. U slučaju vrlo uskih filtara dobijaju se vrlo velike vrednosti za L a male za C tako da nije moguće realizovati upotrbljiv filtar sa relativno malim gubicima .Primeri koje je realizovao autor:
filtar za 14 MHz B = 1MHz C1 = 15pF = 8.2pF + trimer 3 - 9 pF ,C2 = 220 pF , L = 7,8 uH .

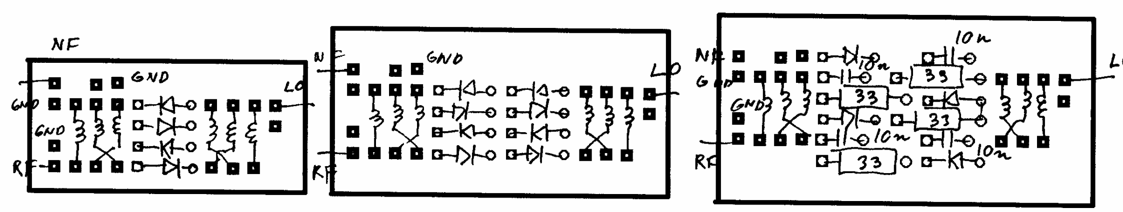
Filter za 3,5 MHz B = 0,5 MHz C1 = 120 pF = 82pF + trimer 60pF , C2 = 850 pF = 820 pF + 33 pF i L = 15,8uH.

-Mešači su najkritičnija komponenta DC prijenmika . Autor je sagradio i testirao razne mešače fabričke i one koje je on ili su njegovi prijatelji pre svega Dule YU1RK sagradili . Nedvosmisleni zaključak koji se nameće kao višegodišnje iskustvo da su najjednostavniji i da najbolje rade diodni dvostruko balansirani mešači sa Schotky diodama ali i običnim diodama Si tipa 1N4148. Naravno fabrički mešači SRA1 , SRA1H, SBL... su bolji imaju nešto manje gubitke a pre svega su bolje balansirani (potiskivanje ulazne frekvencije i oscilatora za mešanje . Razlika sem cene između pravljenih i fabričkih mešača je velika kada pređemo preko 100-200 MHz jer su samograditelji u nemogućnosti da imaju određene kvalitetne komponente i dobro uparene diode kao fabrike. Date su realizacije diodnih mešača sa različitim karakteristikama u pogledu linearnosti (različiti nivoi LO) kao i rasporedi na štampanim pločicama . Zgodno je da su mešači u zatvorenim kutijicama jer na taj način se znatno smanjuju spoljni uticaji na mešač kao i nepredviđeno i neželjeno zračenje mešača na ostatak prijemnika . Date su i realizacije RF transformatora na ulazima i izlazima diodnih mešača . Autor predlaže da se kao nosač transformatora koriste podnožja za integrisana kola na koje su transformatori zalepe sa OHO lepkom . Ovakva konstrukcija “pije vodu” do stotinak MHz . Za više fekvencije treba skratiti izvode žica na minimum .

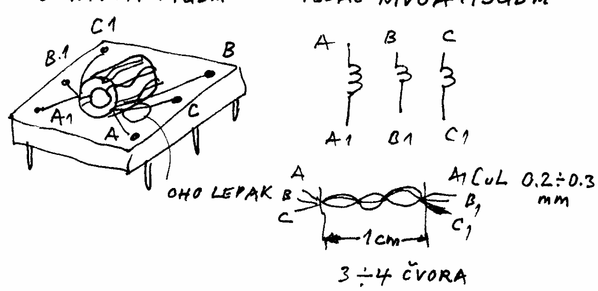
Materijali za RF transformatore treba da su magnetni materijali sa odgovarjućim μ (permeabilnošću) tako da je za najnižu radnu RF frekvenciju ispunjen uslov da je impedansa induktivnosti Z = 6,28 * f * L = 4 * R gde je R ulazno / izlazna impedansa mešača (u našem slučaju 50 Ohm-a) . Praktično najčešće se koriste perlice ili torusi kao na primer FT 37 43 od Amidona. Odli~no rade i torusi sa dve rupe (piggy nose) za asimetri~ne članove kod TV kao i lonci iz međufrekvencija za ST KT . Postoji mogućnost da su feriti provodni , proverava se sa AVO metrom koji treba pokazati beskonačnu otpornost . Može se desiti da se na oš{trim ivicama ferita skine izolacija sa bakarne žice i da



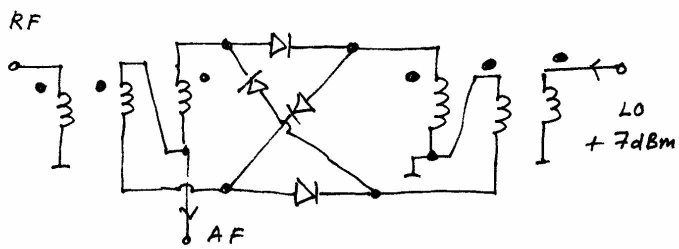
A) B) C)



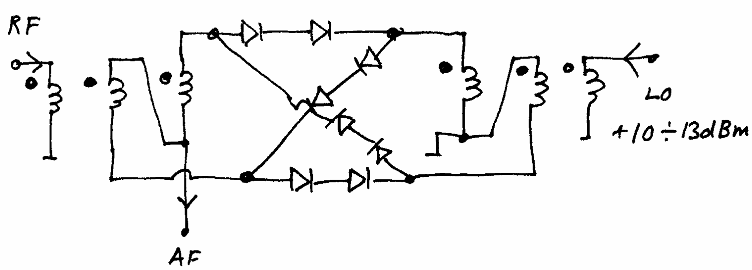
MEŠAČ NIVOA +7dBm MEŠAČ NIVOA +13dBm MEŠAČ NIVOA LO +17dBm



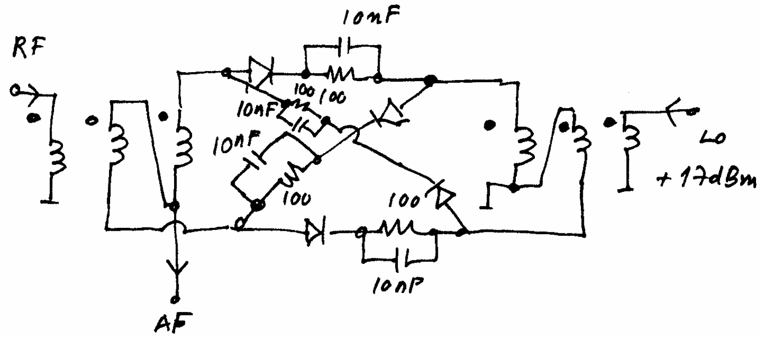
meš{ač “čudno” radi. Umesto Schotky dioda HP2800 , BAS 40 , BA 482 ili BAS 70 odli~no su na KT radile diode tipa 1N4148, 1N914 ili slične. Za motanje tramsformatora traba koristiti trifilarno (tri) , upredene `ice 0,2 - 0,3 mm CuL sa 3 ~vora na 1 cm dužine š{to je kao transmission line impedanse oko 50 Ohm-a. Sa ovakvom trifilarnom (ili bifilarnom) žicom trebaju da se motaju svi širokopojasni transformatori na šemama u ovom članku.



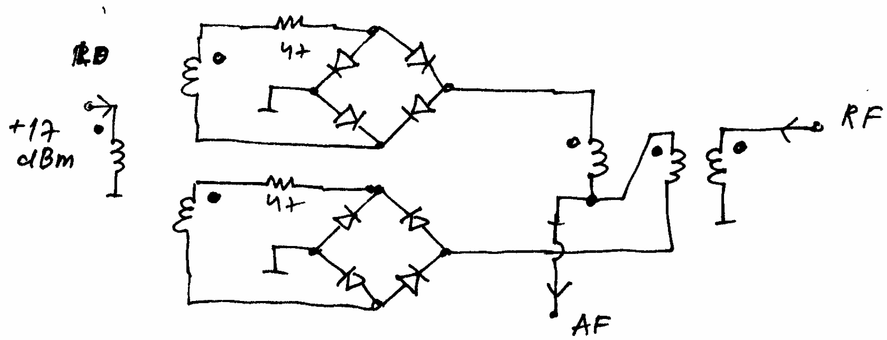
A) IP3in 12 ÷ 18dBm (SBL1,....)



B) IP3in 18 ÷ 22dBm (SBL 2LH, ...)

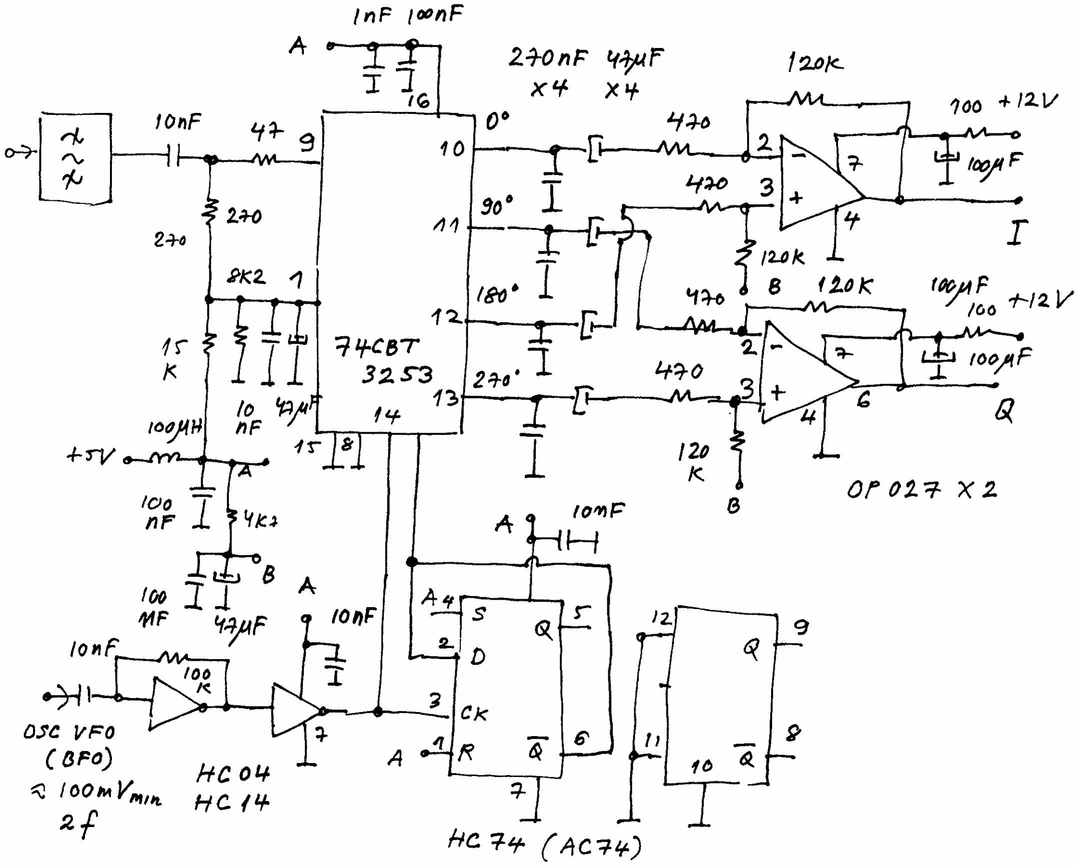


c) IP3in 26÷30 dBm (SRA 1H,....)

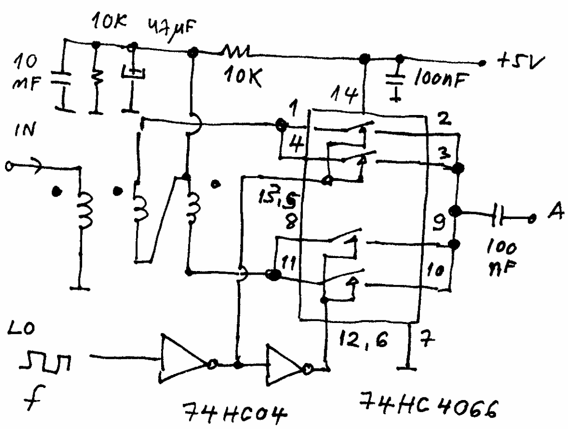


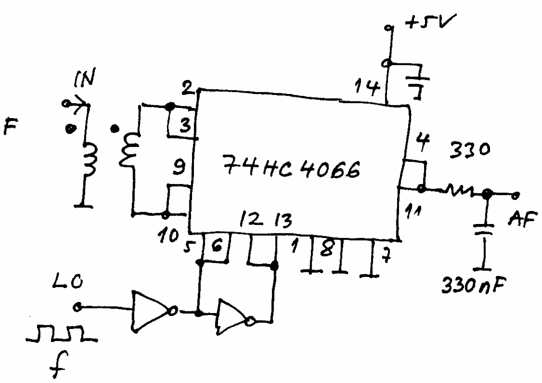
D) IP3in 26÷31 dBm (SRA1H)

Drugi tipovi mešača su veoma inferiorni u svojim specifikacijama pre svega u svojoj linearnosti to jest u mogućnosti da istrpe velike signale na ulazu kao veoma popularni NE 612 ili slični . Motorola je napravila integrisano kolo dvostruko balansni mešač sa Gilbertovom ćelijom koji ima izuzetne karakteristike u pogledu linearnosti . IP 3in je reda 20 dBm kolo radi od 0 Hz do 2 GHz sve to u SMD kućištu sa 8 nožica i sa naponima napajanja do 6,5 V . Mešač MC 13143 obećava ali autor članka nije uspeo da ga nabavi i isproba , ovaj je mešač je za preko 30 dB superiorniji od dobro poznatog NE 612 (602) pa se u budućnosti mogu očekivati dobre konstrukcje DC prijemnici sa njim . Trenutno najviše obećava digitalno kolo 74 CBT 3253 . Kolo je multiplekser 1 na 4 , izuzetnih karaktristika . Otpornost pri preklapanju na 30 MHz je reda 1 Ohm , po katalogugu manje od 5 Ohm-a . Linearnost , koju je izmerio Tayloe N7VE , IP3in bolji od 30 dBm uz gubitke pri konverziji mešanju oko 1 dB !!! Ovaj mešač ima jednu prednost u odnosu na ostale jer mu nije potrebna RF mreža za pomeranje faze lokalnog oscilatora kod DC prijemnika tip 2 i 3 . Pored toga kolo radi kao SCF (Switching. Capacitors Filter) pa imamo jedan problem manje . Kako ništa nije idealno nedostak realizacije sa kolom je da lokalni oscilator LO mora da radi na dvostrukoj radnoj frekvenciji . Dobro se pokazao i mešač sa 4066 kolom koji ima izuzetnu linearnost .Neki autori su vršili predpolarizaciju ulaza no to nije dovodilo do boljih rezultata u pogledu IP3in . Digitalni mešači omogućavaju odnose signal šum S/N preko 60 dB što je teško ostvarivo sa diodnim i drugim tipovima detektora .Važno je napomenuti da za pobudu mešača koriste digitalni signali u protiv fazi to jest pomereni za 180 stepeni.



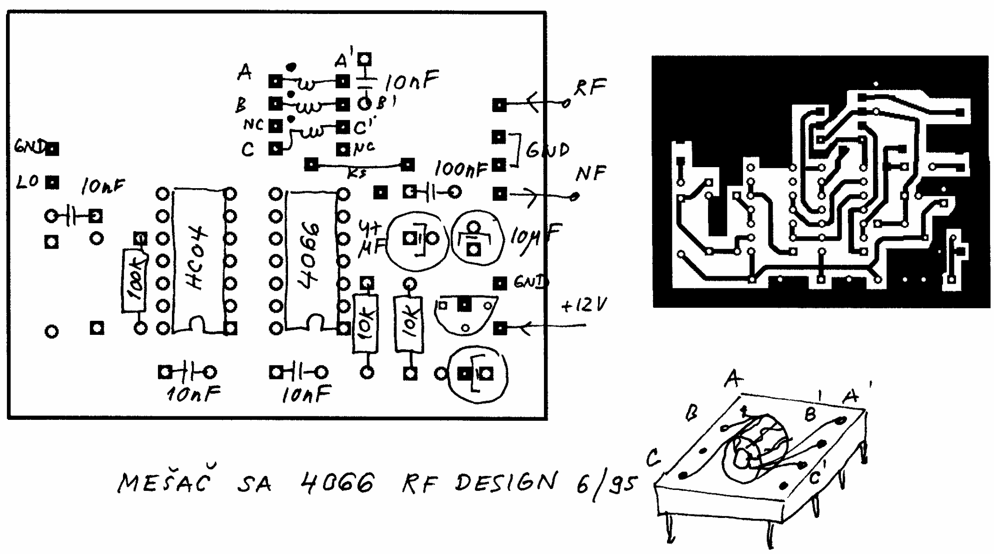
A) N7VE IP3in ≈ 30dBm





B) RF DESIGN 6/'95

c) QRP RAPORT 1/97 DJ1ZB

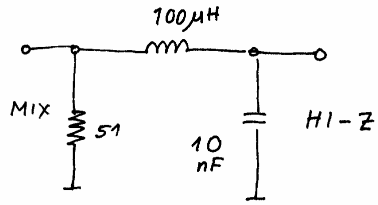


MEŠAČ SA 4066 RF DESIGN 6/95

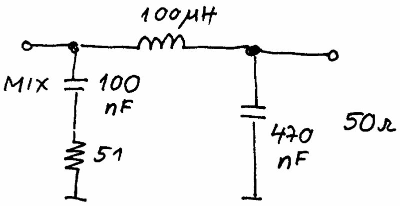
Diplekseri ,za postizanje optimalnih karakeristika mešača veoma su važni diplekseri ro jest mreže kojima su mešači š{irokopojasno , od NF-a do RF-a , zatvoreni . Posebno je osetljiv ulaz IF (NF) diodnih mešača . Ova tema je mnogo razmatrana u literaturi postoje razna rešenja a autor teksta je isprobao mnoga i preporučuje kola sa slike pod B , C , D . Praktična iskustva govore da kod većine mešača nije najbolje rešenje da postoji DC put preko mreže ili otpornika 50 Ohm-a ka masi . Autori kao W. Heyword W7ZOI govore da je najbolji relativno prosto kolo pod C . Komplikovana kola kao kod R2 prijemnika KK7B su dobra ali je teško u realizaciji postići uparenost grana kod prijemnika tipa 2 i 3 . Kod kalemova u diplekseru važno je da su zaliveni dabi se sprečila mikrofonija . Kalemovi mogu biti gotovi , standardnih vrednosti ili da se namotani na odgovaraju}im “ POT “ jezgrima (sa dva lonca) sa AL>=1000 i slično .

Indultivnost kalema je L = Al * n*n gde je n broj zavojaka kalema .

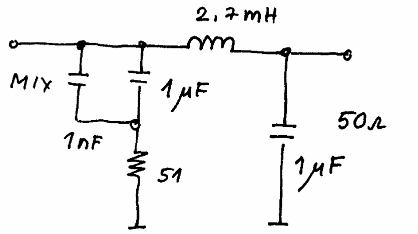
Složenim kolima moguće postići selektivnost na izlazu iz mešača koja se približavaju kristalnim filterima kao kolo pod F. Važno je istaći da kalemovi za dipleksere moraju da imaju što manje gubitke što veći Q (što manja dužina žice i što veći njen prečnik) jer ćemo imati dodatne gubitke i po par dB što I nije neobično ako se koriste mali po dimenzijama zaliveni kalemovi pri niskim impedansama 50 Ohm-a .



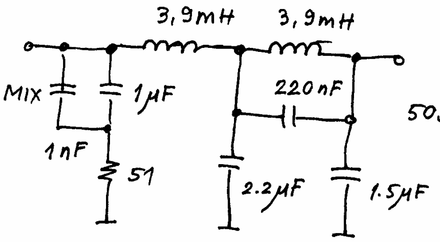
A) W7ZOI



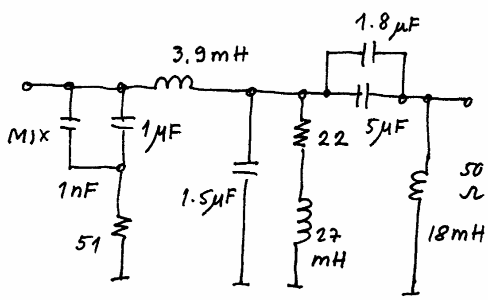
B) W7EL



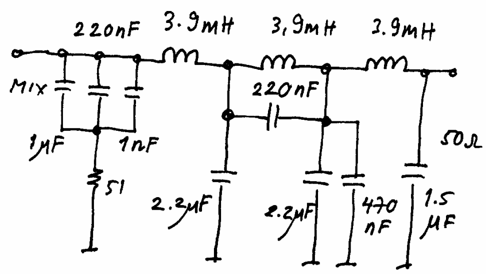
C) W7ZOI QRP.POP.NET



D) YU1LM (SSB)

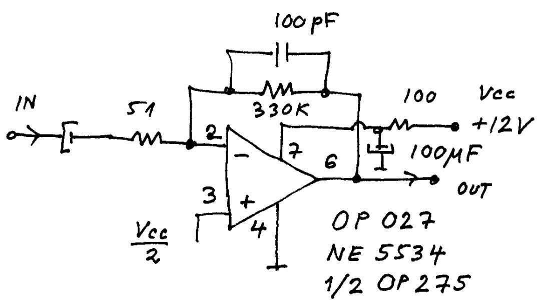


E) KK7B R1(R2) SSB

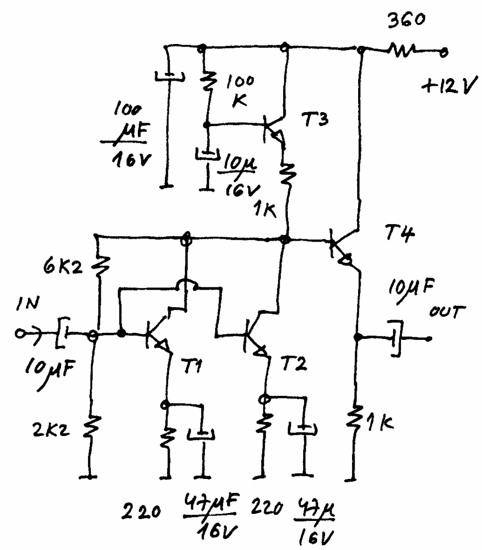


F) YU1LM -70dB (5KHz) SSB

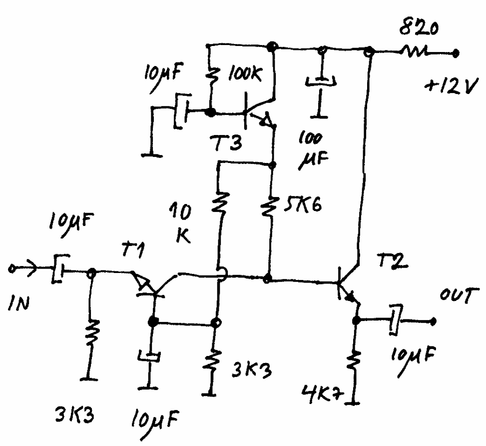
-Posle dipleksera nalazi se predpojačavač koji ima zadatak da pojača demodulisani signal i da ima istovremeno mali faktor šuma veliki dinamički opseg i da je ulazna impedansa 50 Ohm-a. Problem je sličan rešavanju predpojačavača za MC i MM glave u audio tehnici . Kao u slučaju dipleksera i ovde je u literaturi predloženo sijaset rešenja . Najjednostavnije rešenje i uvek ponovljivo je da se stavi malošumni operacioni pojačavač .Nažalost minimalni šum OP nije kada je ulazna impedansa 50 Ohm-a . Moguće rešenje je da se koristi NF transformator za prilagođenje na minimalni šum OP no to nije baš popularmo rešenje danas . N7VE koristi OP 027 u svom prijemniku , OP027 je izuzetno malošumni OP prihvatljive cene ali bi se sigurno bolje karakteristike postigle sa tranzistorima ili specijalnim kolima tipa MAT3 , 4 i sličnim. MAT kola su upareni malošumni diferencijalni parovi . Autor je isprobao razna rešenja počevši od onog koje je predložio W7EL . Spoj sa uzemljenom bazom je i dalje je dobar izbor jer sa dobija dobar faktor šuma bolji od 2 dB (zavisno od tipa tranzistora BC 413 , BC550..) . Pojačanje je reda 30 ili više dB. Kolo ulazi u saturaciju kada je ulazni detektovani signal reda 10 mV p-p što odgovar ulaznom signalu od preko 59 plus 60 dB . Slične karakreristike ima predlog VE3DNL koji predlaže spoj sa uzemljenim emiterom . Prednost ovog spoja je da kada se stave upareni tranzistori istog pojašanja +/- 5 % dobija se šum koji je manji za kvadratni koren iz broja tranzistora . Ovo unapređenje potiče od toga što je šum nekorelisana (slučajna) veličina za paralelne tranzistore dok je primani signal korelisana . Praktični rezultati su da se dobija sa 4 tranzistora BC 550C pojačanja većeg od 200 faktor šuma oko 0,5 dB što je odličan rezultat (neki autori su isprobali i spoj sa 16 paralelnih tranzistora) . Verovatno bi diferencijalni par MAT 3 i slični u istoj šemi dao još i bolje rezultate . Ovo kolo određuje prag prijema , to jest MDS , odnosno faktor šuma DC prijemnika (aproksimacija gubici pre predpojačavača + faktor šuma predpojačavača) . Ostali tipovi predpojačavača sa JFET i MOS FET nisu dali tako dobre karakeristike . Kada predpojačavač pojača detektovani signal tridesetak decibela mogu se koristiti OP AMP ali vodeći računa da im se propusni opsezi pojačanja ograniče niskopropusnim filterima



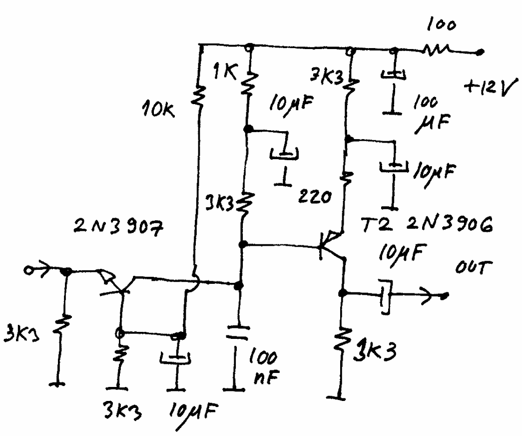
A) DL7AJY CQDL 3/91



B) VE3.... SVI TRANZISTORI BC550 ILI SLIČNI MALOŠUMNI



C) W7EL - SVI TRANZISTORI BC550 ILI SLIČNI MALOŠUMNI

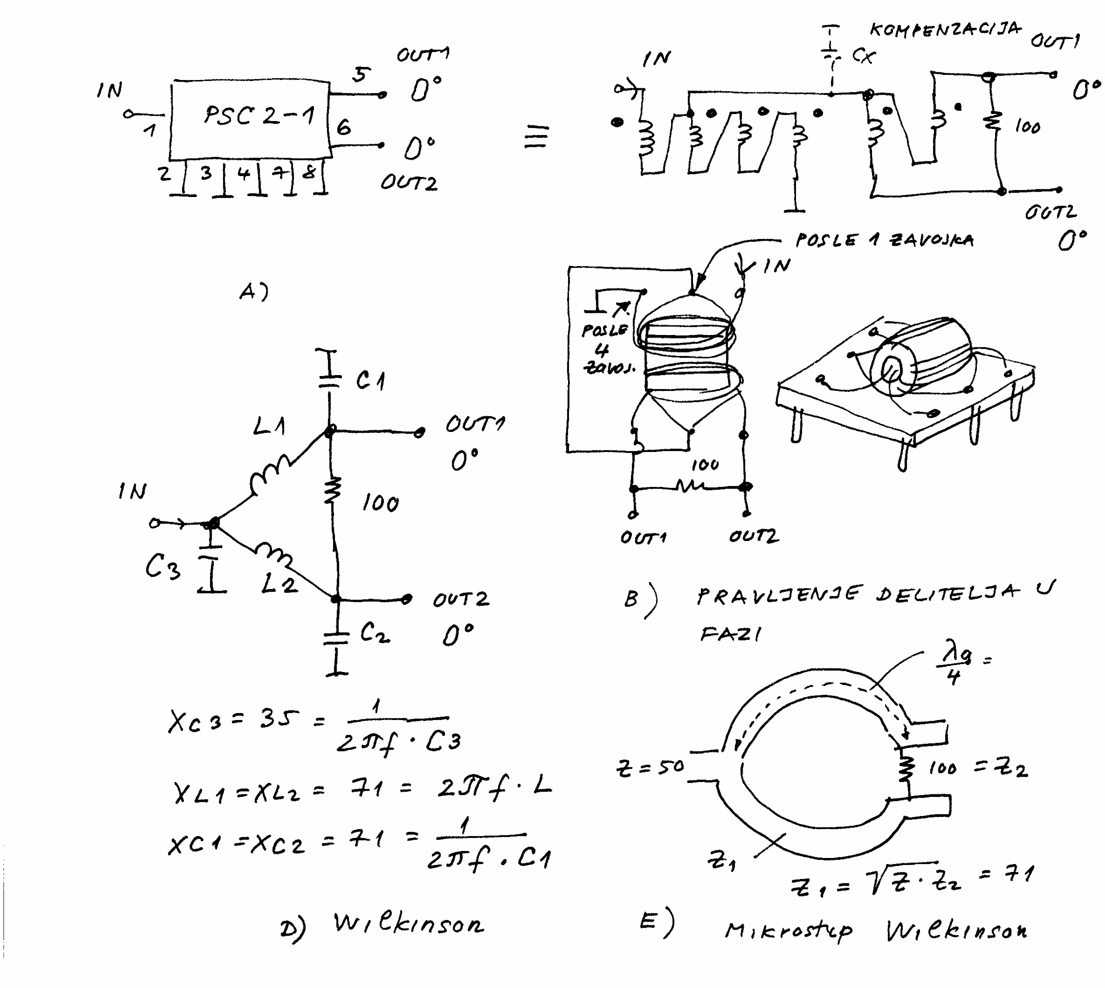


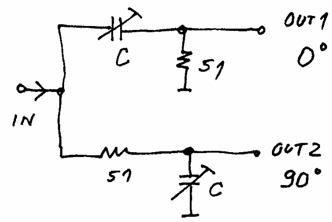
D) W7ZOI ARRL HANDBOOK 1994

-Delitelji snage mogu biti širokopojasni (PSC 2-1 Mini Circuits 1-500 MHz) ili uskopojasni kao na primer Wilkinson-ovi . Tako|e u DC prijemnicima su važni i delitelji snage pomerači faze za 90 stepeni . Važno je da se zbog što boljih karakteristika pomerači faze za 90 stepeni nalaze na delenju snage lokalnog oscilatora . Razlog je da promene amplitude se tada , ako su male , mogu zanemariti pa je potiskivanje audio imidža veće i zavisi skoro isključivo od razlike faze. Ovde su dati primeri za neke tipove RF pomerača faze i delitelja u fazi i kako se oni realizuju . Izbor odgovaraju}eg delitelja u fazi ili kvadraturi zavisi od želja i mogućnosti .
Prosti pomerači faze su obično uskopojasni . Relativno prost a dovoljno širokopojasan pomerač u kvadraturi je dat pod G od KK7B koji u realizaciji za 14 MHz dobro radi od 13. 5 MHz do 15 MHz dok su svi ostali sem pomerača pod F značajno uskopojasniji .

Pomerači faze na RF-u i audio nivou do{li su na loš glas u šesdesetim godina kod tada popularnih SSB primopredajnika po faznim metodama jer su bili u kolima sa elektronskim cevima . Grejanje istih i loš kvalitet komponenti dovodili su da se performanse menjaju i da se potiskivanje audio imidža , odnosno drugog bočnog opsega i nosioca pri predaji mnogo menjaju u radu i vremenu . Sada je situacija sasvim suprotna jer je kvalitet komponenti i njihova preciznost značajno poboljšana , zatim grejanje koje utiče na stabilnost karakteristika je kod tranzistorske tehnike znatno smanjeno. Sa druge strane nabavljivost komponenti je takođe mnogo veća pa ne postoje više tako veliki razlozi da se od ove tehnike toliko " beži " s obzirom da je moguće postići odlične karakeristike i prijemnika i predajnika . Potiskivanja imidža odnosno drugog bočnog opsega kod predajnika moguće je postići i do 60 dB jer je nabavka tačnih komponeneti danas relativno dostupna stvar .

Nabavka komponenti tačnosti od 1% ne predstavlja problem (Burklin) . Neki noviji treansiveri koriste ovu tehniku I i Q (grana u kvdraturi) na poslednjoj međufrekvenciji reda 10 – 50 kHz sa DSP procesorima.

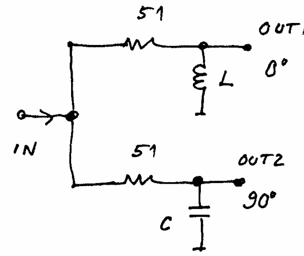




$X_C = 50$

$C = \frac{1}{2\pi f \cdot 50}$

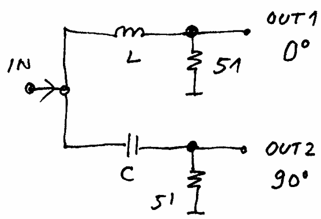
A)



$C = \frac{1}{2\pi f \cdot 50}$

$L = \frac{50}{2\pi f}$

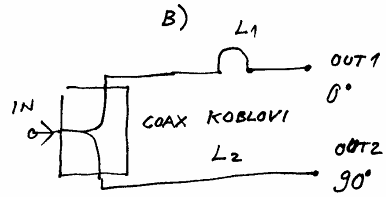
B)



$C = \frac{1}{2\pi \cdot 50}$

$L = \frac{50}{2\pi f}$

C)

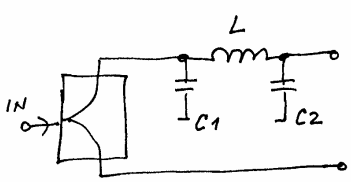


DELITELJ U FAZI

L_1 VEĆE OD L_2 ZA $\frac{\lambda g}{4}$

ZA RG174 $\lambda g = 0.67\lambda$

D)

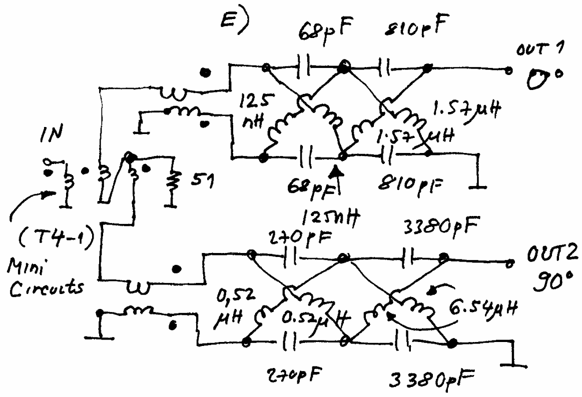


DELITELJ U FAZI

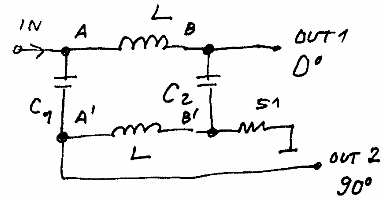
$X_{C1} = X_{C2} = 50 = \frac{1}{2\pi f \cdot C}$

$X_L = 50 = 2\pi f \cdot L$

E)



F) 2 ÷ 30 MHz



KK7B SPRAT '92

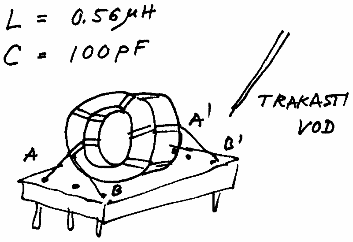
$X_L = 50 = 2\pi f \cdot L$

$X_{C1} = X_{C2} = 100 = \frac{1}{2\pi f \cdot C}$

ZA 14 MHz

$L = 0.56 \mu H$

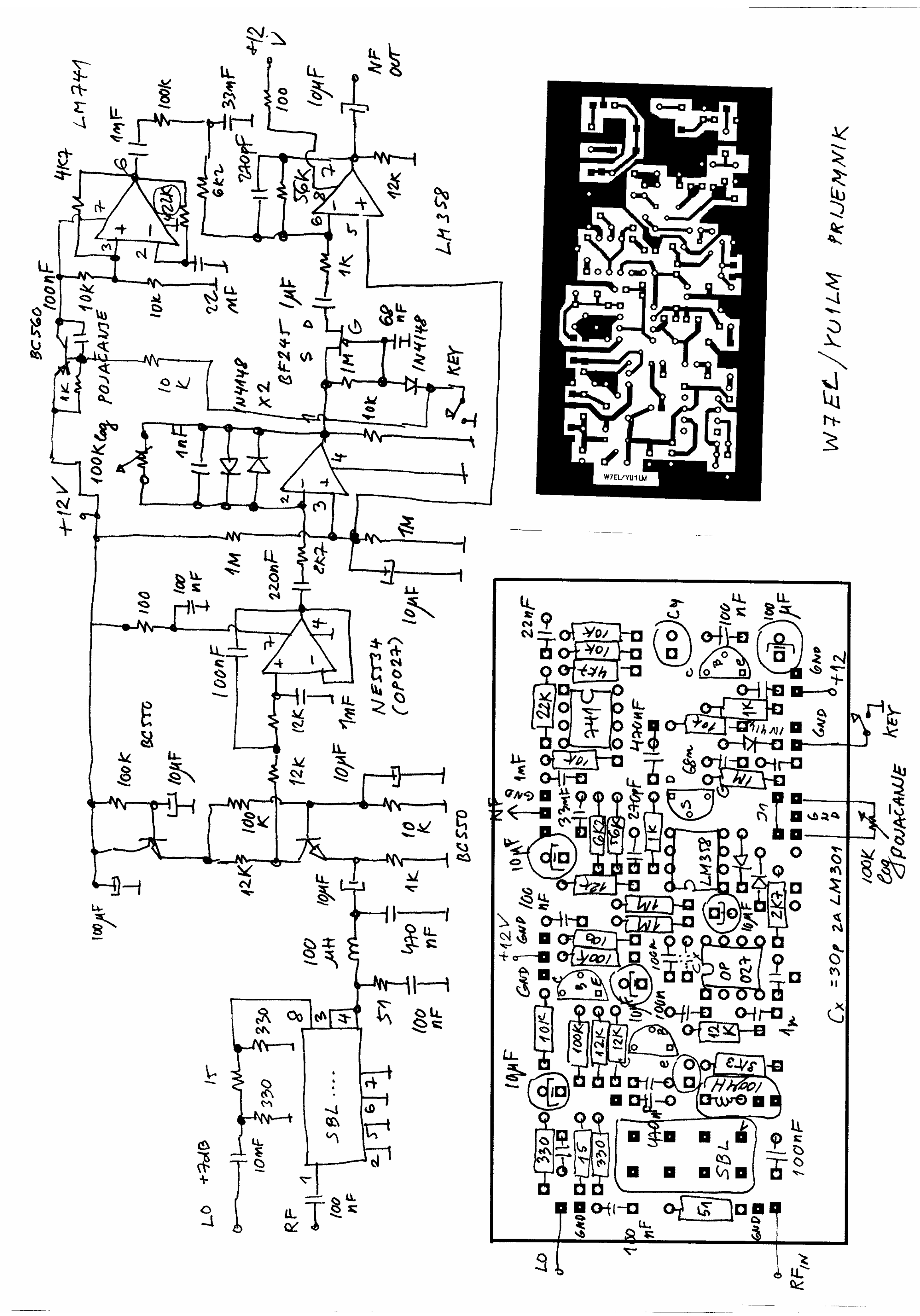
$C = 100 pF$

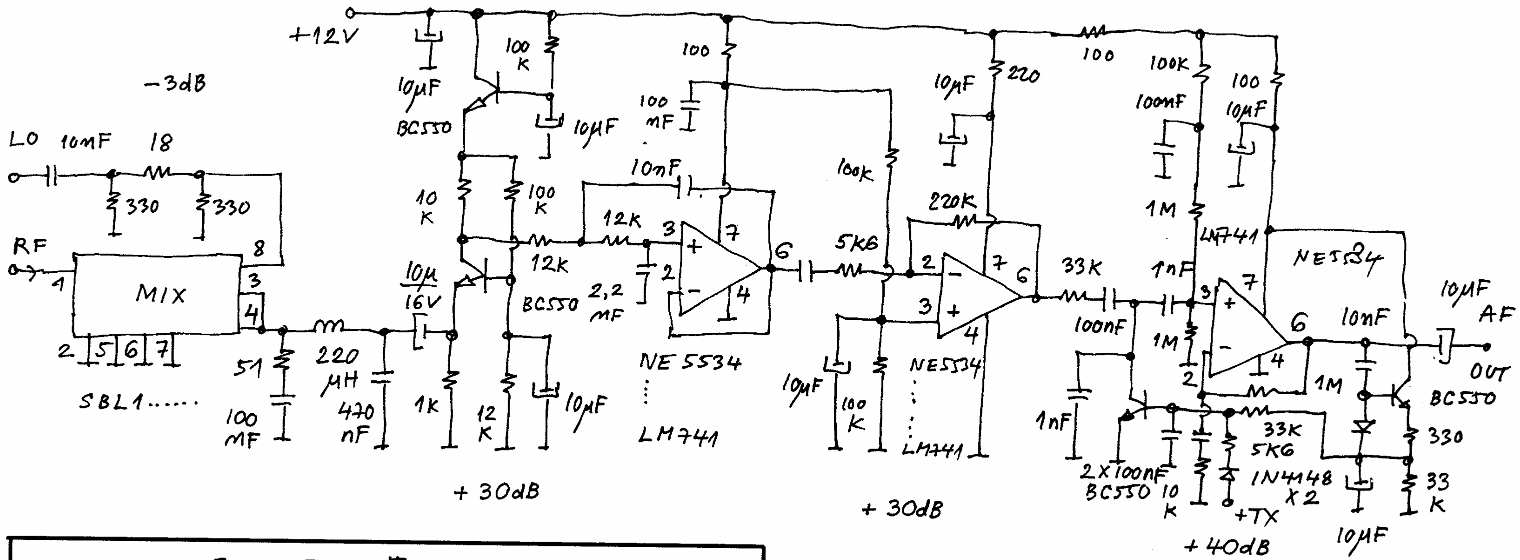


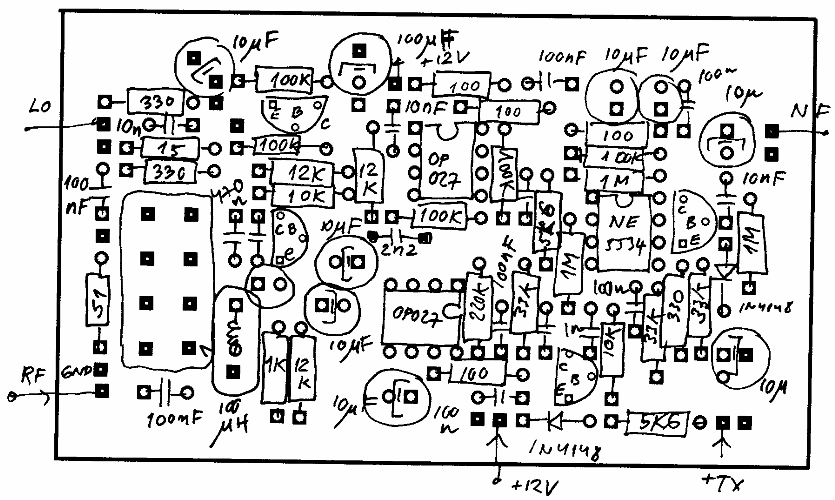
FINIM POMERANJEM NAMOTAJA NAMEŠTA SE NAJBOLJE POTISKIVANJE PRE FIKSIRANJA "OHO" LEPKOM

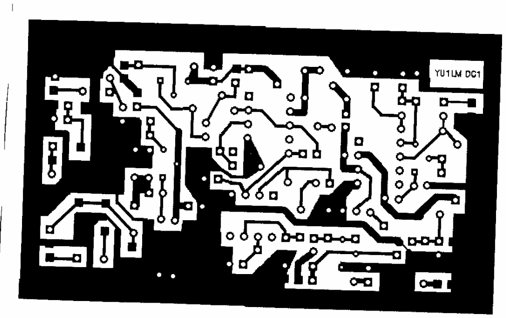
G)

DC Prijemnici prvog tipa









YU1LM DC PRIJEMNIK

Prijemnici prvog tipa su najprostiji , oni imaju nedostatak što primaju i drugi bočni opseg pa su im zato karakeristike za oko 3 dB lošije od druga dva tipa .Dat su dva prijemnika : jedan je verzija W7EL (realizacija ZL2BCW i moja verzija stampane ploče) i drugi je verzija koju sam razvio i koji je sličan prethodnom prijemniku ali ima audio AGC .Ovaj prijemnik omogućava da se prijatnije slušaju na opsegu velike gužve kao što su na primer DX-ovi ili kontesti . Manji nedostatak prijemnika je da postoji “ pumpanje “ tipično za audio AGC , opseg regulacije je nešto veći od 50 dB što je sasvim dovoljno za prijatno slušanje na opsegu . Prijemnici su prosti i njihova ponovljivost je jako dobra i to je veoma dobar početak za DC prijemnike i da se vidi kvalitet koji oni omogućavaju pri prijemu . Dva ista prijemnika ovog tipa mogu poslužiti kao osnova za prijemnika 2 i 3 tipa sa dodatkom mreža za pomeranje audio faze i delitelja u fazi na ulazu u prijemnik ili stavljanjem Weaver-ovog detektora . Odgovarajući bočni opseg dobija se izborom faza audio pomeračkog lanca i sabiranjem dve grane prijemnika .

Prijemnici drugog tipa

Drugi tip prijemnika je onaj koji daje relativno najbolje rezultate . Stepen komplikovanosti koji je naophodan za postizanje performansi je različit od prijemnika tipa 1 ali suština je da je neophodno realizovati kvalitetne pomerače faze za 90 stepeni na audio i na RF nivou.

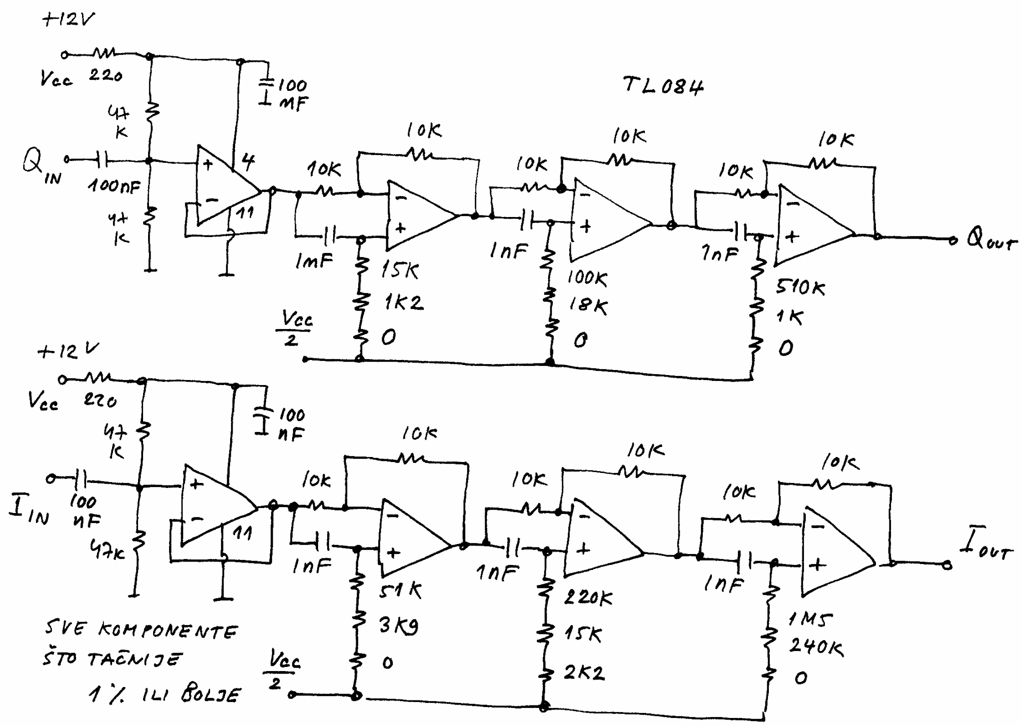
Data su tri tipa mreže za pomeranje audio signala . Najprostije kolo je veoma staro autor W2KUJ (realizacija G3TDZ za projekat DC prijemnika objavljenog u časopisu Radio Communication 1976 i u Spratu 1990 “ White rose receiver “). Važno je da su kao kod svih mreža komponente što tačnije tolerancije 1% ili bolje, potiskivanje drugog bočnog opsega je reda 37-40 dB od 350 – 3300 Hz . Važno je primeti da su pojačnje različito u granama . Nešto komplikovanije kolo je sa all pass mreža sa operacionim pojačavačima OP sa kojim je moguće potiskivanje imidža veće od 40 dB u istom opsegu . Na štampi je ostavljena mogućnost da se tačnije vrednosti dobiju konbinovanjem otpornika i kondenzatora . Potiskivanje audio imidža menja se kroz opseg od 300 – 3300 Hz jer postoji talasanje oko 90 stepeni .

Najbolje rezultate mogu}e je posti}i sa polifaznim sistemom popularisan od HA5WH u Radio Comminication 1976 i detaljno analiziran od JA1KO u QEX 6/1995 . Stepen komplikovanosti je veći jer imamo veći broj komponenti ali one sada ne moraju kao kod pretkodnih rešenja da imaju tačnost od 1% već zadovoljavaju i komponente tačnosti 5 % . Potiskivanja od imidža od 60 i više dB ne predstavlja problem . Za pobudu polifaznog sistema koristi se drajver koji se koristi i za treći tip DC prijemnika S53MV.

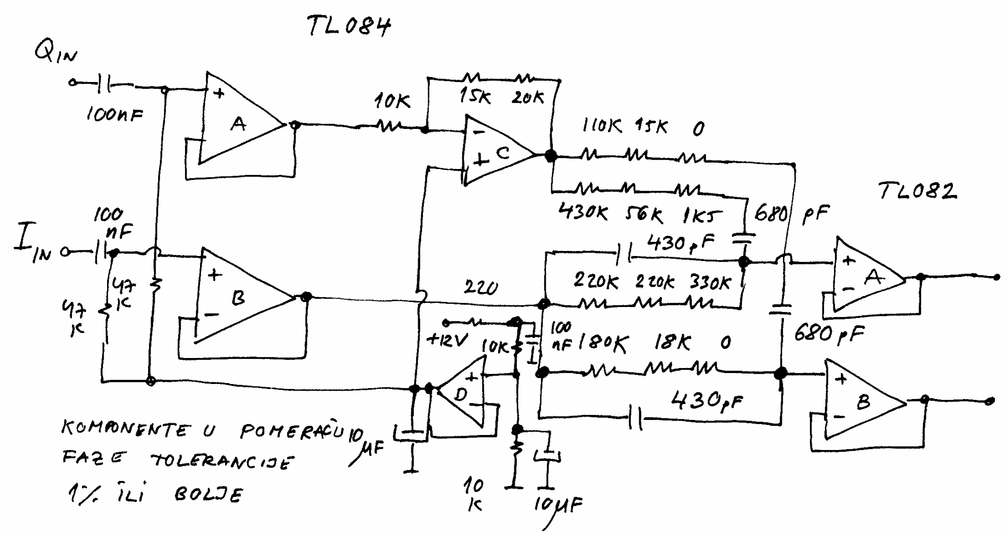
Potiskivanje imidža u zavisnosti od tačnosti pomeranja u I Q granama je

Fazna gre{ka (stepen)	potiskivanje imid`a (dB)
0.125	53.24
0.5	47.16
1	41.11
2	35.01
3	31.42
4	28.85

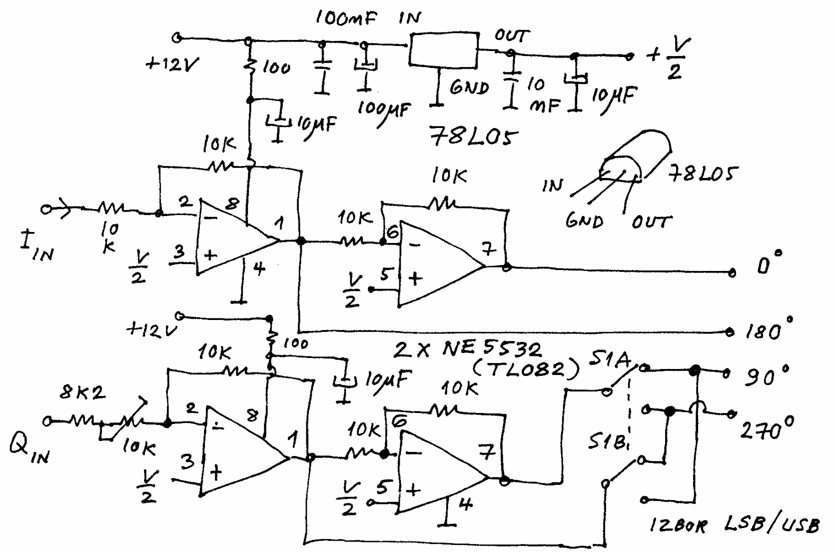
Ovi rezultati važe pod uslovom da nepostoji amplitudski debalans između I i Q grane jer se u protivnom rezultati dodatno kvare . Polifazne mreže imaju gubitke koji se kreću od 6 do 11 dB pa o tome treba voditi računa pri planiranju pojačanja u DC prijemnicima.



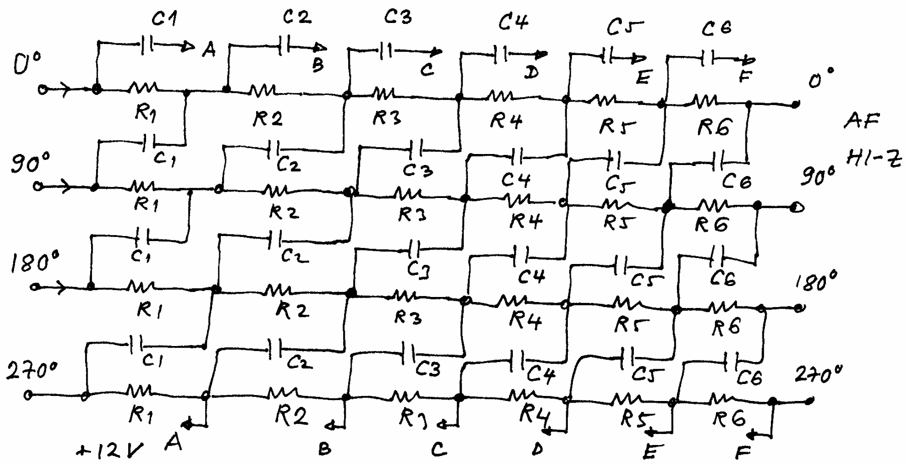
A) PHILIPS POMERAČ FAZE U AUDIO OPSEGU

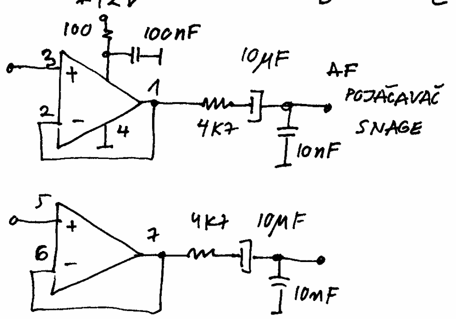


B) AUDIO POMERAČ FAZE "WHITE ROSE" G3TDZ



POBUDA ZA POLIFAZNI POMERAČ FAZE ILI DEMODULATOR S53MV





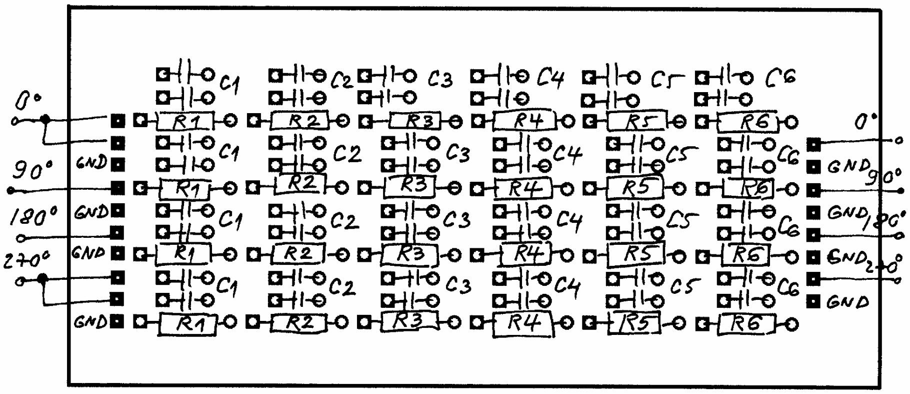
VERZIJE

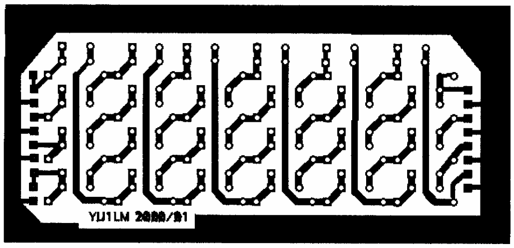
A) R1 = R2 = R3 = R4 = R5 = R6 = 12K
C1 = 22nF+22nF, C2 = 33nF, C3 = 10+10 nF, C4 = 10nF, C5 = 5,6nF
C6 = 4,7nF

B) R1 .... R6 = 10K, C1 = 47nF, C2 = 33nF
C3 = 22nF C4 = 15nF, C5 = 10nF C6 = 5,6nF

c) C1 .... C6 = 10nF R1 = 47K R2 = 33K
R3 = 22K R4 = 15K R5 = 10K R6 = 5,6K

POLIFAZNI POMERAČ FAZE U AUDIO OPSEGU SA "BUFFER"-OM

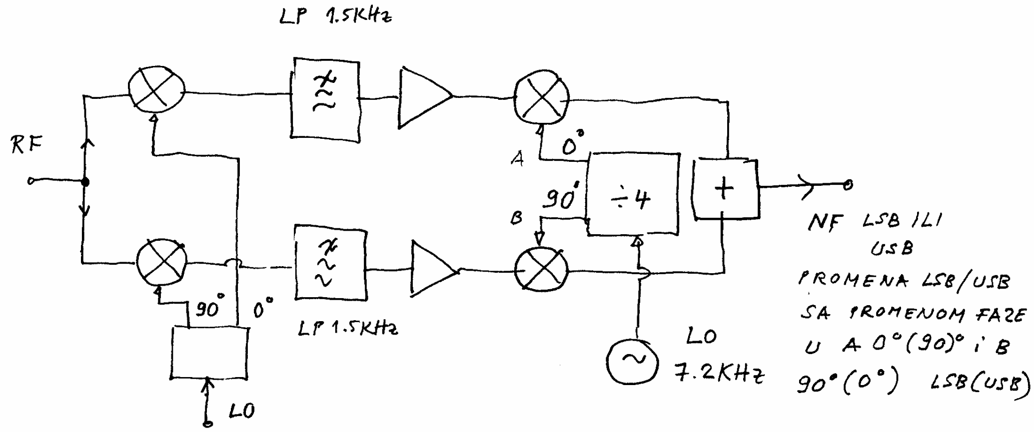




AUDIO POLIFAZNI POMERAČ FAZE

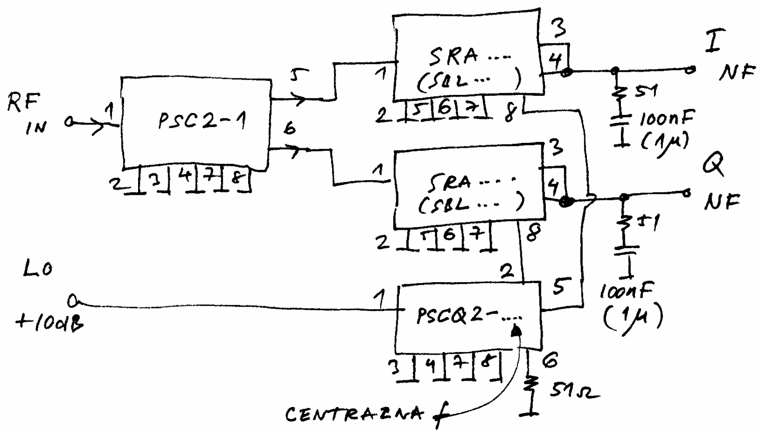
Prijemnici trećeg tipa ili DC prijemnici po Weaver-ovoj metodi

Ovaj tip DC prijemnika je najkomplikovaniji i najteže se razume jer prosto neverovatno izgleda da je moguće postići potiskivanje neželjenog i izdvajanje korisnog bočnog opsega kada se modulisani spektri ukrste.
Blok šema prijemnika Weaver demodulatora data je na sledećoj slici .Ova metoda detakcije polazi i od jedne objektivne karakteristike ljudskog govora da je opseg u kome je gore navedeni pomoćni nosilac “ prazan “ to jest da nema mnogo korisnih komponenti koje utiču na kvalitet prijema odnosno razumljivost govora . NASA je za svoje komunikacije sa posadama koje su putovale na mesec izbacivala ovaj deo opsega ili ga koristila za telemetriju životnih funkcijama astronauta . Iako izgleda kao najjednostavniji način za detekciju sa potiskivanjem imidža metoda nije bez mana Moraju se koristiti vrlo “ oštri “ niskopropusni filtri koji moraju da potisnuti pomoćni nosilac koji i pored dobrog balansiranja " curi " i koji se u prijemu čuje kao konstantan ton . Mali “ problemčić “ koji je uvek prisutan kod DC prijemnika sa potiskivanjem imidža, za postizanje maksimalnog potiskivanja potrebna je dobra uparenost grana u kvadraturi I i Q amplitudski i fazno. Za ovu metodu date su dve verzije prijemnika za koju je napravljen digitani generator pomo}nog nosioca koji radi u oba slučaja i koji koristi jeftini kvarc iz satnih mehanizama na 32768 Hz . Modul se sastoji od oscilatora sa 4011 i delitelja sa 3 sa 4013 .Signal 10922 Hz se satim vodi na kolo 4029 koji je UP/DOWN broja~ presetovan da deli sa. 16 Na izlazu se dobijaju frekvencije 5461 , 2731 , 1365 i 687 Hz koje su potrebne za demodulator i modulator od M.Vidmara S53MV(ex YU3MV) objavljenog u CQ S5 časopisu i na Internetu sajtu S5 saveza WWW. HAMRADIO.SI . Drugi demodulator je dat u časopisu CQ DL 12/1984 od autora B.Kainka DK7JD ovde je izdvojen deo koji je kompatibilan sa ostalim modulima i kome je potreban signal u kvadraturi dobijen iz digitalnog modula delenjem frekvencije 5461 Hz sa 4 integrisanim kolom 4013 ovaj deo radi i u predaji . Demodulacija sa pomoć}nim nosiocem obavlja se sa kolom 4066 (CD ili HEF) na koga se dovode u svakoj grani signali u protiv fazi , 4066 radi kao dvostruko balnsni mešač .Izbor bočnog opsega se obavlja tako što se u jednoj grani promene mesta faze pomoćnog nosioca na demodulatoru. Ako se isti modul koristi kao predajni pri prelasku na predaju se radi ista operacija ali u kontra pravcu .

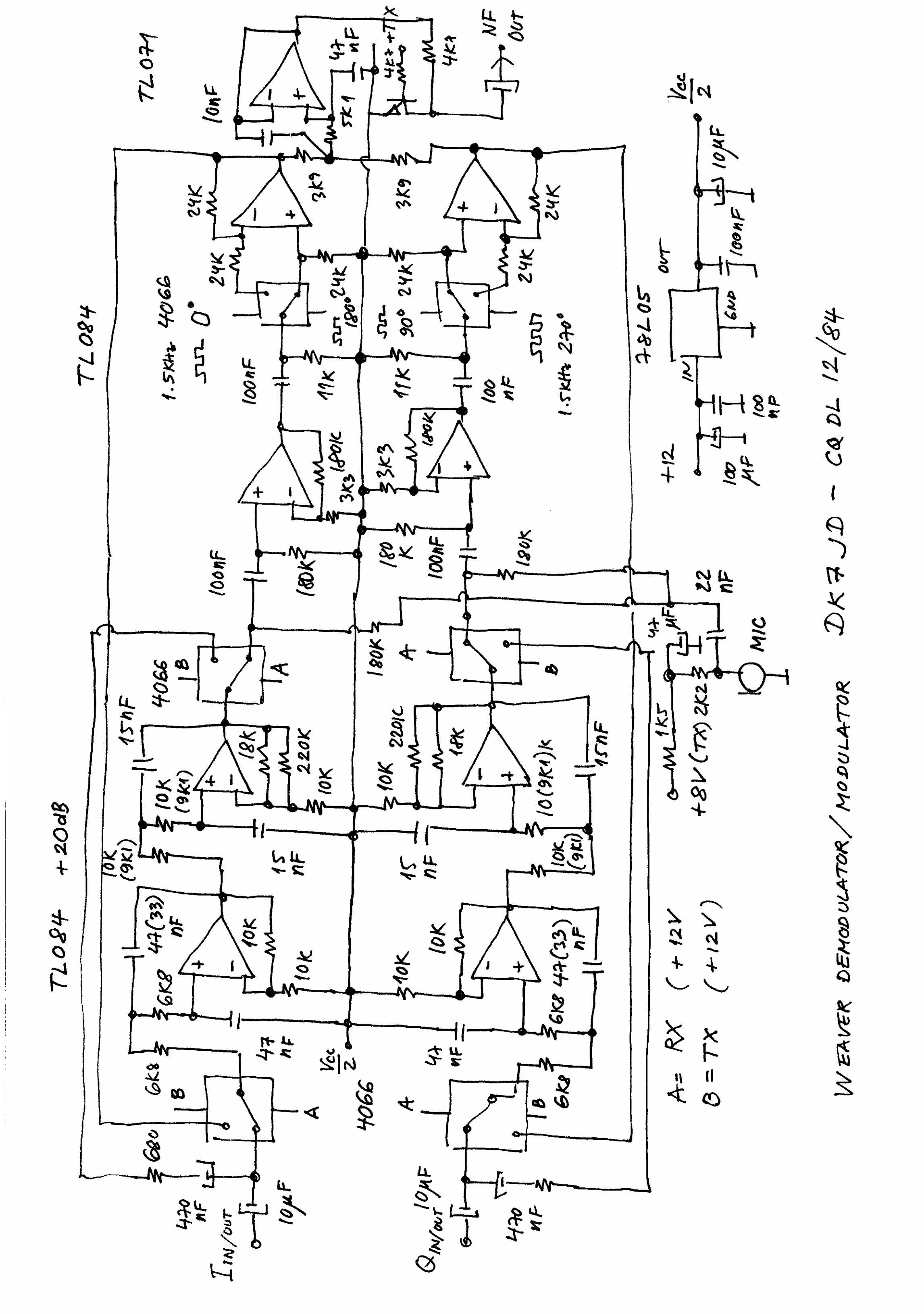


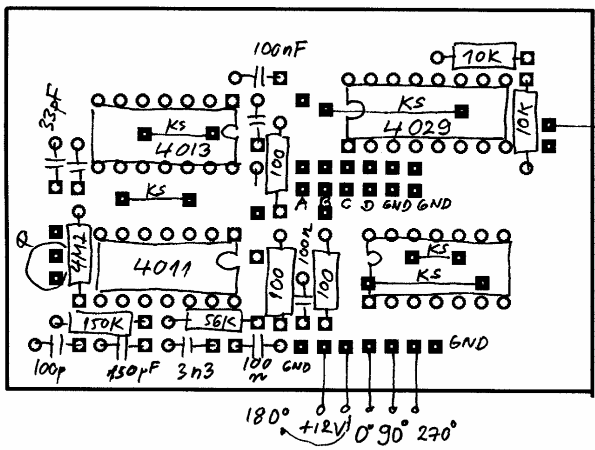
WEAVER-OV DEMODULATOR DC PRIJEMNIK TIP 3

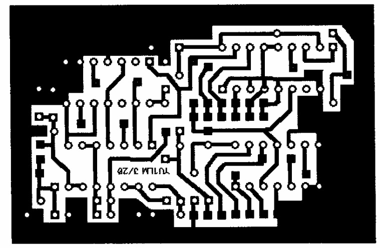
S53MV koristi polifazni sistem za demodulaciju sa anlognim multipleksеrom 1 na 8 kolom 4051 . Na koga se dovode gore navedeni signali za upravljanje i koji preko R mreže konbinuju ulaze i na taj način izdvaja željeni bočni opseg (LSB ili USB) . Kolo je relativno prosto i zbog polifaznog sistema potiskivanje parazitnog nosioca je relativno lako , izbor bočnog opsega vrši se izborom smera brojanja UP ili DOWN na kolu 4029 .



A) I-Q (KVADRATURNI DEMODULATOR) ZA PRIJEMNIKE 2 i 3

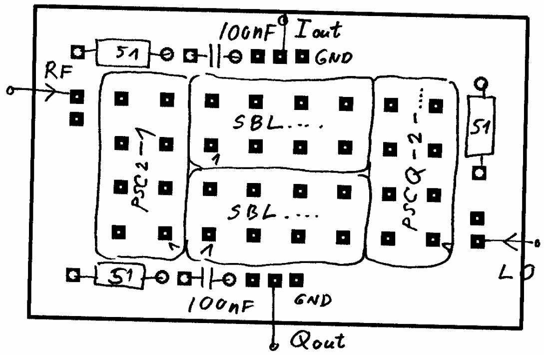

WEAVER DEMODULATOR / MODULATOR
DK7JD - CQ DL 12/84
A = RX (+12V)
B = TX (+12V)
TL084 +20dB
TL084
TL071
4066
78L05
MIC
NF OUT

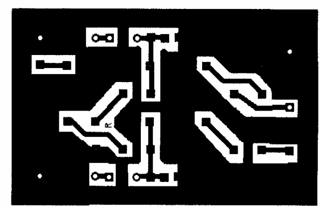


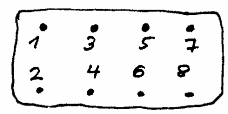


KS – KRATKOSPOJNIK

GENERATOR TAKTA ZA S53MV/DK7JD DEMODULATORE
(U SLUČAJU KORIŠĆENJA Q 3n3 KRTKOSPOJITI)

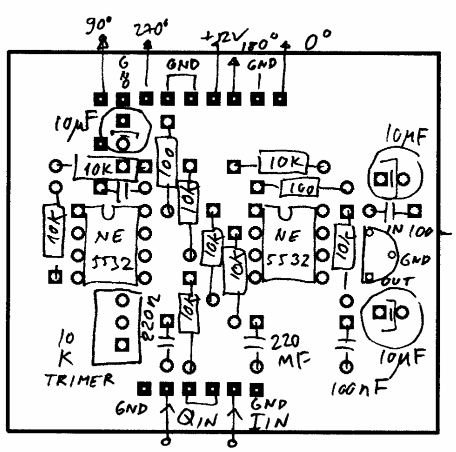


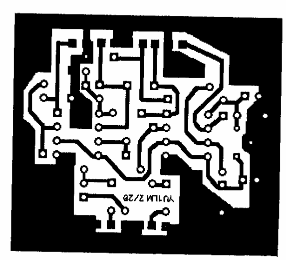




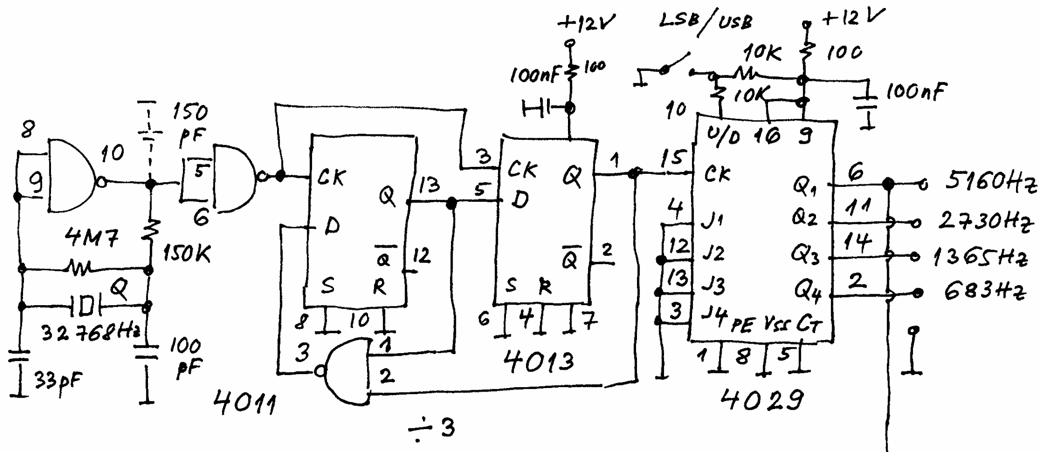
POGLED ODOZDO

I-Q DEMODULATOR ZA PRIJEMNIKE 2 I 3 TIPA SA MEŠAČIMA, DELITELJIMA I POMERAČIMA FAZE MINICIRCUTS

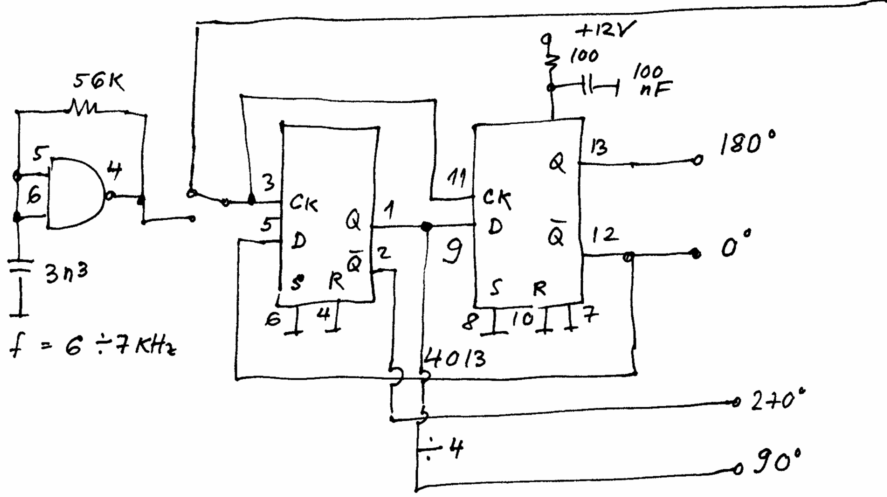




DRIVER ZA POLIFAZNE SISTEME N7VE, S53MV...

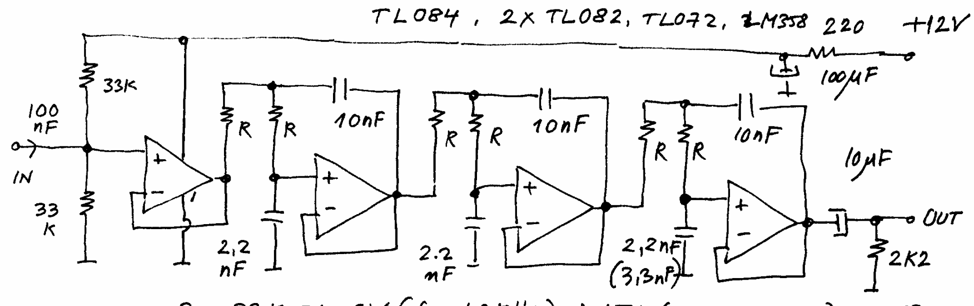


S53MV GENERATOR TAKTA ZA WEAVEROV DEMODULATOR



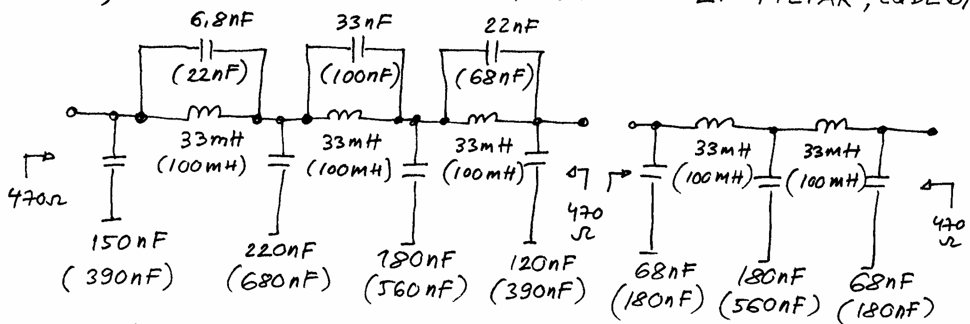
GENERATOR ZA DK7JD DEMODULATOR

Još jedna stvar na koju se vrlo često zaboravlja ali bez razloga je NF pojačavač na kraju pojačavačkog lanca DC prijemnika . Neko će reć}i kako pojačavač na kraju lanca može da utiče na performanse DC prijemnika ? Po teoriji analize prijemnika uzima se najuži propusni opseg i na osnovu njega se računa osetljivost , dinamika , faktor šuma.....Ova aproksimacija je tačna ako posle tog najužeg propusnog opsega nemamo mnogo pojačanja. Kod DC prijemnika to nije slučaj jer posle niskopropusnog filtera imamo često i po 60 – 100 dB pojačanja . Da bi predviđene projektovane perfomanse DC prijemnika ostale treba da imamo niskopropusni filtar sa fc 1,2 kHz (CW) ili 3.3 kHz.(SSB) neposredno ispred NF pojačavača snage. Najednostavnije i u praksi su se pokazali niskopropusni filteri sa slike pod A dobri su i LC filteri ali su “ komplikovani “ za realizaciju pod B . SCF filteri su korisna stvar jer omogućavaju LP filtere sa promenljivom graničnom frekvencijom dobar izbor je MAX 293 popularisao YU1AD u časopisu Radio Amateri . Važno je napomenuti da se SCF filteri koriste kada je nivo signala dovoljno veliki reda 1 V . Na nižim nivoima ulaznog signala javljaju se izobličenja i kvari se odnos izlazni S/N na izlazu prijemnika .

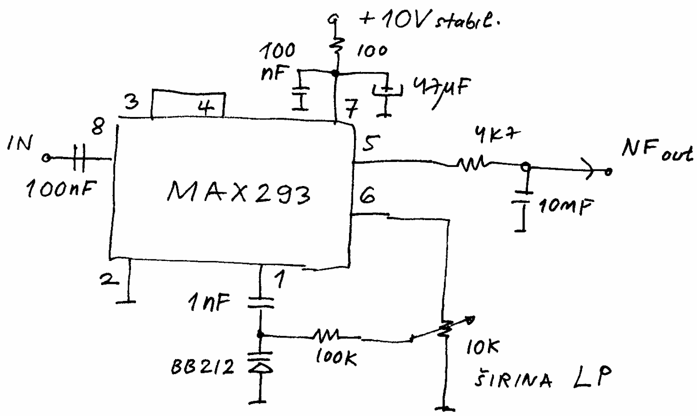


R = 33K ZA CW (fc = 1.2KHz) ; 15K (fc = 2.2KHz) ZA SSB

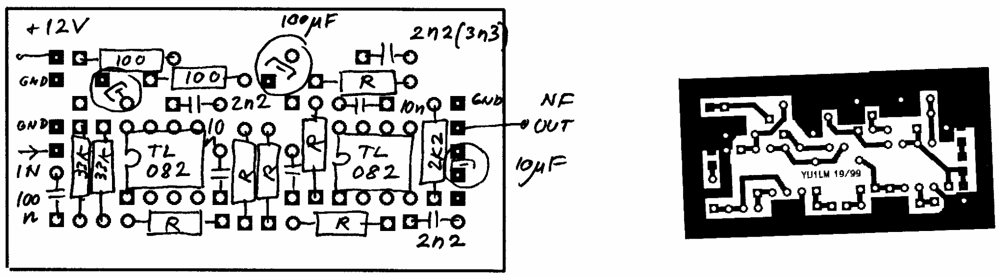
A) ARRL HANDBOOK 1994 AKTIVNI LP FILTAR, CQ DL 6/82



B) LP SSB (CW) FILTERI IZ PRIJEMNIKA R1 (R2) KK7B QST 8/92

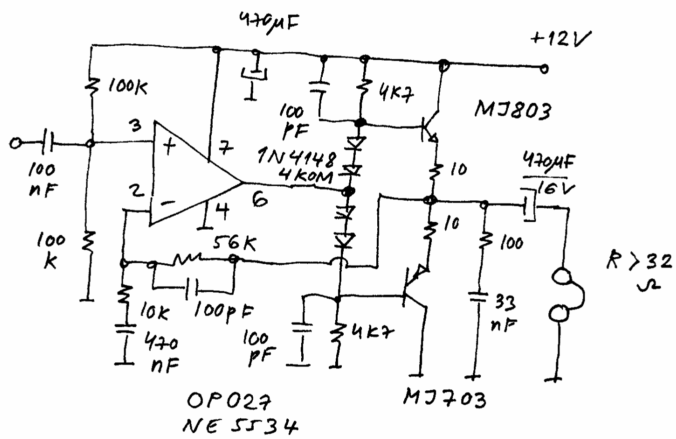


C) SCF PROMENLJIVI LP FILTAR



AKTIVNI AUDIO LP FILTER CQ DL 6/82

Ugradnja LP filtar pod A daje veoma veliki subjektivani a i praktični napredak u kvalitetu i selektivnosti prijema kod DC prijemnika .

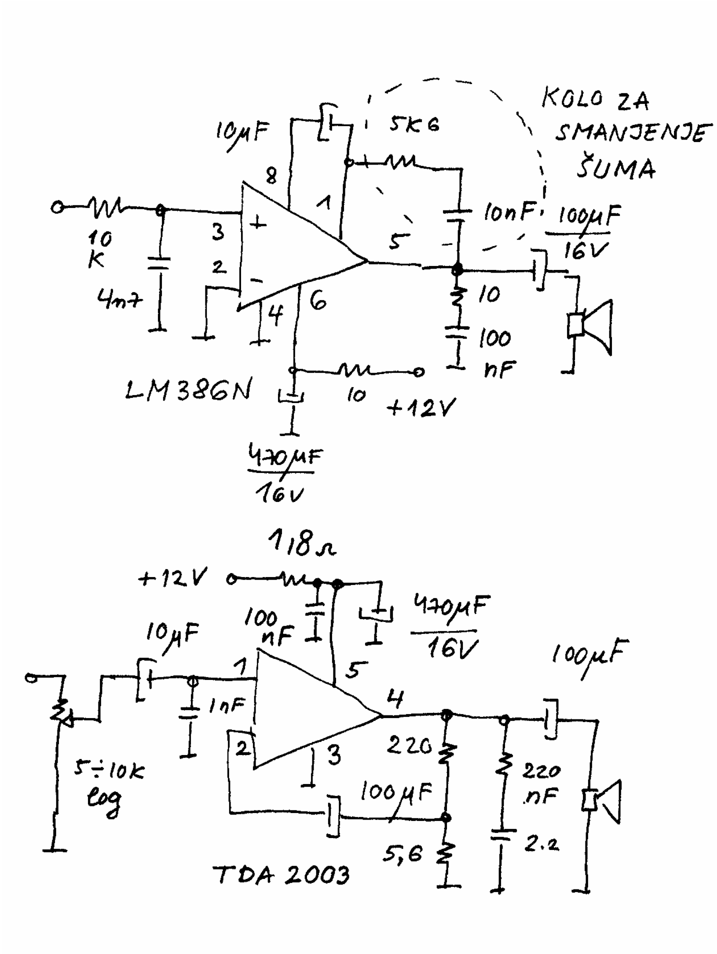


Izlazni audio pojačavač snage ,jedna od stvari koja se pri gradnji DC prijemnika zanemaruje je NF audio pojačavač snage. Najčešć}e se u gradnjama koristi LM386 koji je veoma jednostavan i ekonomičan NF pojačavač koga bi za bilo koju ozbiljniju gradnju trebalo izbegavati iz više razloga. Pre svega pojačavač je prava “Nijagara” što se tiče generisanja š{uma , zatim pojačanje je preveliko jer se iz njega “isteruje” preko 40 dB mada je moguće postići i čitavih 76 dB. Data je šema koja ograničava preterani šum koji generiše čip ako se želi upotreba istog. Pojačanje NF pojačavača snage za kvalitetan prijem treba da je u opsegu 20-26 dB. Preporučio bih direktnu zamenu za LM 386 sa mnogo boljim performansi integrisano kolo SSM 2211 od firme National Semiconductor . Praktično je mnogo bolje koristiti NF pojačavač sa TDA 2003 za auto-radijske pojačavače koji je mnogo kvalitetniji ,mnogo manje šušti a linearnost mu bolja jer za razliku od LM386 koji može dati 1 W on daje kvalitetnih 4 W šema je data uprilogu. Autor za prijem uvek koristi slušalice kod kojih se gore navedeni nedostaci jasno uočavaju. Preporučio bih onima koji imaju aspiracija za izuzerno kvalitetnim prijemom NF pojačavač za sluš{alice koji mo‘e dati oko 100 mW snage a čiji je kvalitet visokog HI-FI pojačavača a pojačanje je 15 dB.

Na kraju dat je predlog uređaja čiji je “ design “ u toku zajedno sa Mikijem YU1KM i Goranom YU1GD a koji ima za želju da iskoristi prednosti DC i superheterodinskih prijemnika zajedno . Ideja je da se napravi DC prijemnik / predajnik na međufrekvenciji reda 70 – 80 MHz i koji bi bio osnova za za SSB / CW primopredajnik za KT , 50 MHz , 144 MHz i 430 MHz . Poš{to bi međufrekvencija bila “ visoka “ potiskivanje simetrične kod superheterodinskog prijemnika bilo bi dovoljno veliko preko 80 dB. Sa druge strane DC prijemnik bi bio za vrlo uzak opseg frekvencija 100 – 500 kHz na 70 – 80 MHz pa je moguće postići vrlo dobre karakteristike u potiskivanju audio imadža , odnosno drugog bočnog opsega. Ovakav Uređaj bi se po nekim po specifikacijama približio (ali ne i po dimenzijam i snazi) popularnom IC 706 odnosno FT 100 . Sintetizator za ovakav uređaj bi bio relativno prost jer bi se promena frekvencije na visokoj MF obavljala sa “ super ” VCXO-om na 10 MHz .Ovakav sistem obezbeđuje dovoljnu stabilnost i malošumnost generisanog signala. Sintetisanje frekvencija lokalnog oscilatora za prvo mešanje za pojedine amaterske opsege prijemnik obavljalo bi sa kristalnim oscilatorom ili sintetizatorom sa krupnim korakom 250 – 500 kHz.

Zahvaljujem se svima pre svega Draganu Dobričiću YU1AW koji je par puta pokušao da me “ ubedi “ i da moja višegodišnja iskustva i saznanja o DC prijemnicima prenesem na papir kao i ostalima koji su mi pružili podršku oko ovog rada.

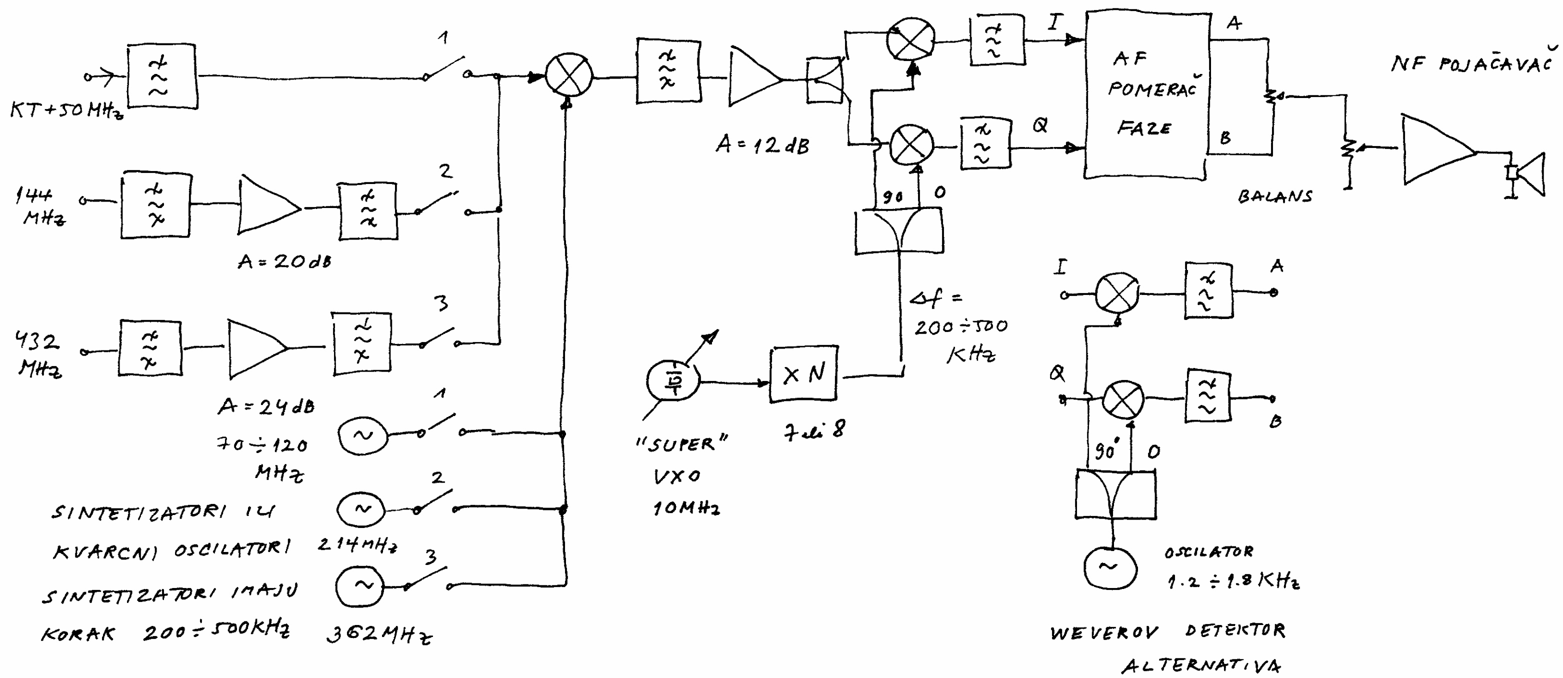
Izvinjavam se zbog eventualnih grešaka i što zbog velike prezauzetosti nisam uspeo da rad uradim onako kako sam želeo pre svega električne šeme i PCB-ove. Svima želim uspešnu gradnju a za eventualne probleme obratite mi se na E-mail adresu STASIC@eunet.yu ili tasa@imtel-mikrotalasi.co.yu



NAPOMENA

ŠTAMPANE PLOČE SU POGLED SA STRANE ELEMENATA !!!!!!

ZBOG SKENIRANJE SVI PCB-OVI ŠTAMPANE PLOČE NISU U RAZMERI 1:1



„SUPER DC" PRIJEMNIK KOJI KORISTI PREDNOSTI SUPERHETERODINSKIH I DC PRIJEMNIKA. PROJEKAT YU1LM, YU1GD I YU1KM U REALIZACIJI

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5.A Multimode Phasing Exiter for 1-500 MHz Rick Campbell KK7B – QST 4/1993
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8.40-m-Konverter mit IP3=+30dBm Wolfgang Schneider DJ9ES – Funk Amateur 12/1996
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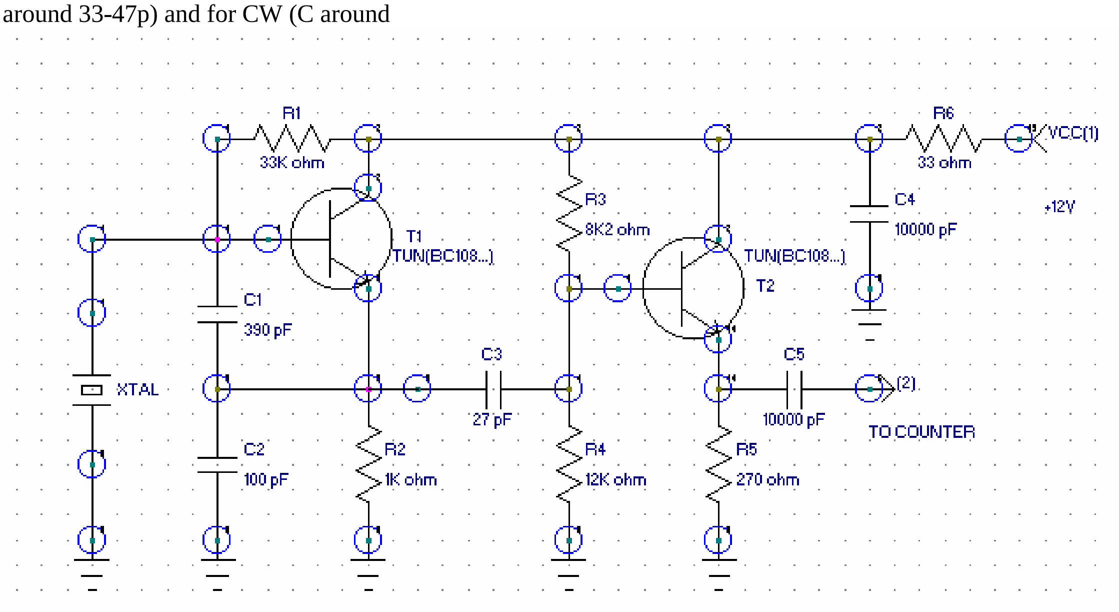
23. Ringmischer mit Vierfach HCMOS Schalter Hans Joachim Brandt DJ1ZB – QRP Raport 1/1997
24. QRP Primopredajnik Milorad Todorović YU1WR – Radio Amater 7,8,9 /1986
25. http://qrp.pops.net/qrp/ sajt posve}en pokojnom Doug De Maw- W1FB od strane W7ZOI i prijatelja

Crystal Filter with Variable bandwidth for CW/SSB

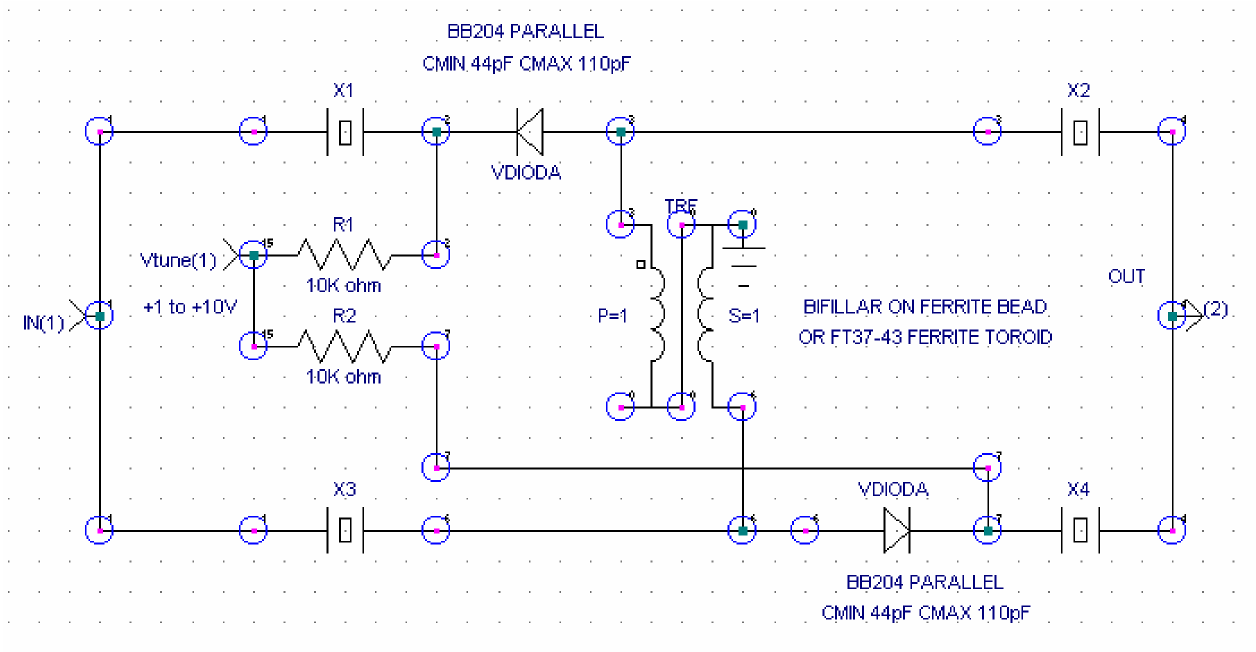
ing Tasic Sinisa-Tasa , YU1LM/QRP   stasic@eunet.yu

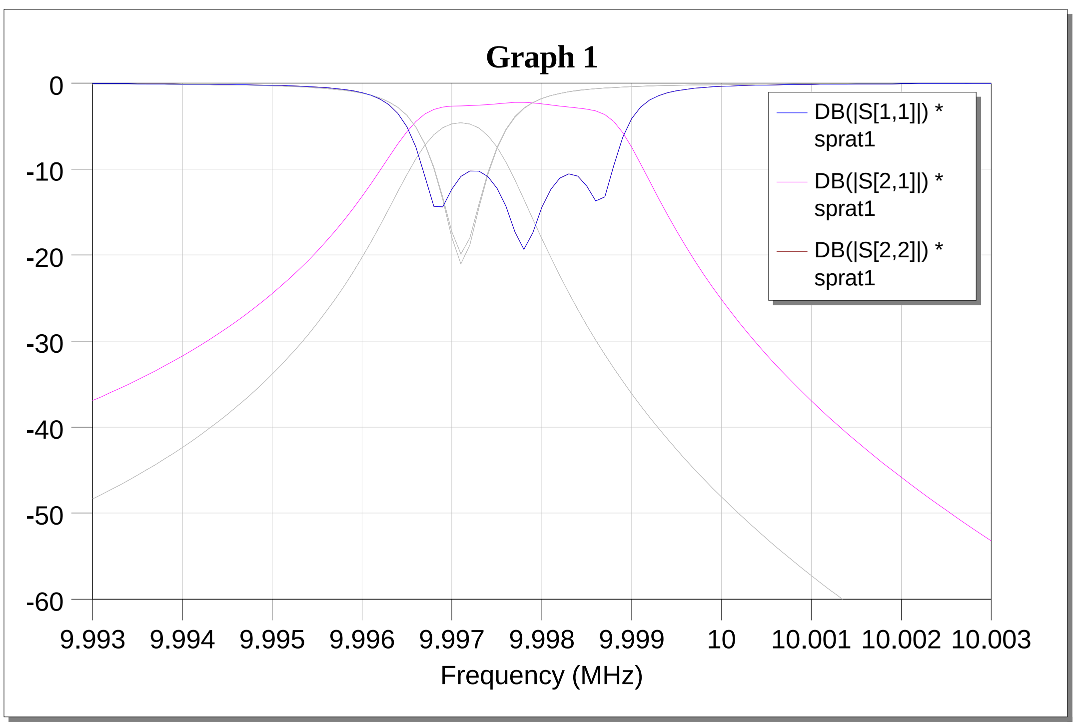
I like to have crystal filter with variable bandwidth which will satisfy SSB/CW use and I try some design with ladder crystal filter .I felt disappointment with results ,first filter insertion loss was change very much with change of bandwidth and second input/output impedance was far away from 50 Ohms. I adore modules with 50 Ohms impedance because it is very easy to “play” and make new receiver/transmitter design on board it’s like RF “LEGO” brick. Here is results of design, see figure 1, I made in very mighty RF CAD Program Microwave Office 2001 which is possible to free download on address http:// www.mwoffice.com as 30 days trial version. Practically I made this crystal filter, some kind of half lattice filter ,and agreement with design was very good. To obtain good agreement it is necessary to match crystal units in some kind test oscillator see figure 2 During the matching crystal units we are measuring frequency on the counter and the difference between units for good match is less than 60-80Hz. Crystal units are very cheep about 1.5 DEM or less and it is possible to use this design for any crystal frequency in crystal fundamental mode practically to the 25-30 MHz .Also is possible to use crystal units from old PC boards than the price is practically near zero(be careful PC crystals are sometimes third overtone (24MHz example) and sometimes are not good for filter use because of spurious response(parasitic pass close to the working frequency)). Crystal filter is near 50 Ohm system and it is possible to cascaded to obtain better filter skirt. I suggested that crystal filters are between IF amplifier (very easy build with MMIC MAV11 from Mini Circuits or similar type) . Varactor diodes are from the FM receiver BB204 (104)type, it is two diodes type in one package and for this purpose I connected this two diodes in parallel . Control voltage is changing on R potentiometer from 1V to 10V and I appreciate to use stabilised voltage .If we have intension to use crystal filter only for CW work it is possible to decrease bandwidth (-3dB) down to 200Hz or even less if we connect parallel C to diodes (for example 47pF) than the relative change of filter bandwidth will be reduced also we shall increase insertion loss .One more thing for CW detection it is necessary to use USB carrier. Also if we don’t like to have variable bandwidth it possible to use fixed capacitors instead varactor diodes .Experimentally it is necessary to determinate fixed capacitors because values depend from crystal type and wanted bandwidth .Some practical guide for SSB C have to be small(typically around 33-47p) and for CW (C around



CRYSTAL TEST OSCILLATOR

100-330pF) .I made few crystal filters of this type for other frequencies (8MHz ,10.7MHz and 20MHz)with fixed bandwidth and filters are very good especially for the CW use. GL with construction 72/73 Tasa YU1LM/QRP


BB204 PARALLEL
CMIN 44pF CMAX 110pF
X1
VDIODA
X2
R1
Vtune(1)
10K ohm
+1 to +10V
R2
10K ohm
IN(1)
TRF
P=1
S=1
BIFILLAR ON FERRITE BEAD
OR FT37-43 FERRITE TOROID
OUT
(2)
X3
VDIODA
X4
BB204 PARALLEL
CMIN 44pF CMAX 110pF


Graph 1
0
-10
-20
-30
-40
-50
-60
9.993
9.994
9.995
9.996
9.997
9.998
9.999
10
10.001
10.002
10.003
Frequency (MHz)
DB(|S[1,1]|) * sprat1
DB(|S[2,1]|) * sprat1
DB(|S[2,2]|) * sprat1

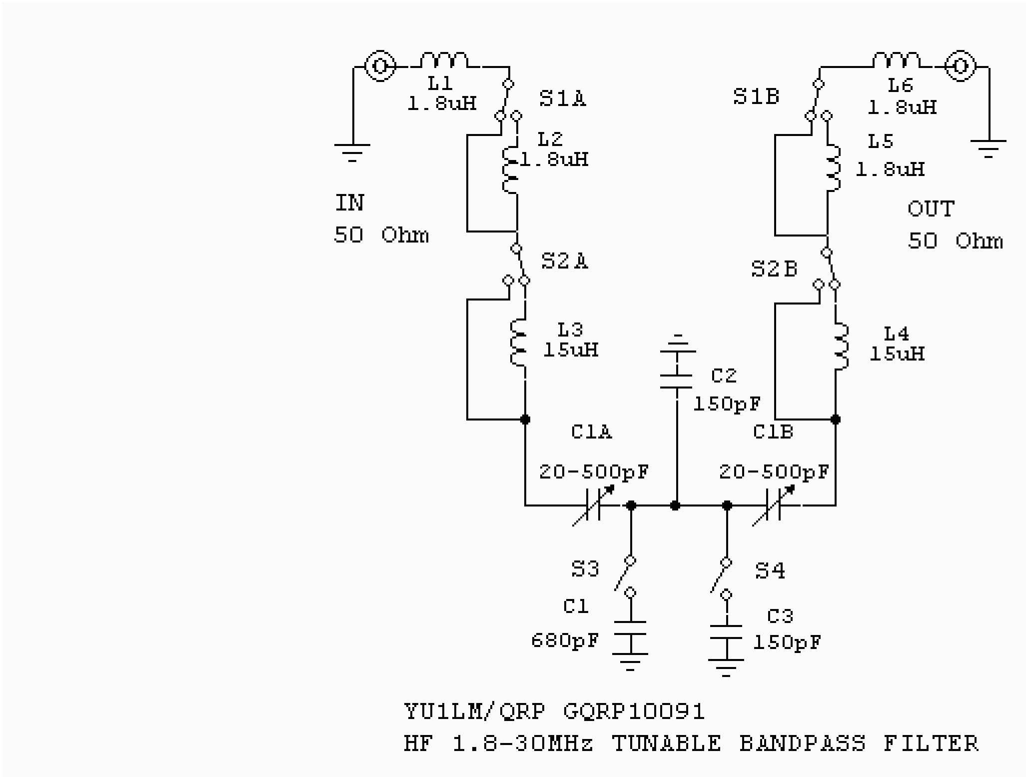
TUNABLE BANDPASS FILTER FOR ALL HF BANDS (160m-10m)

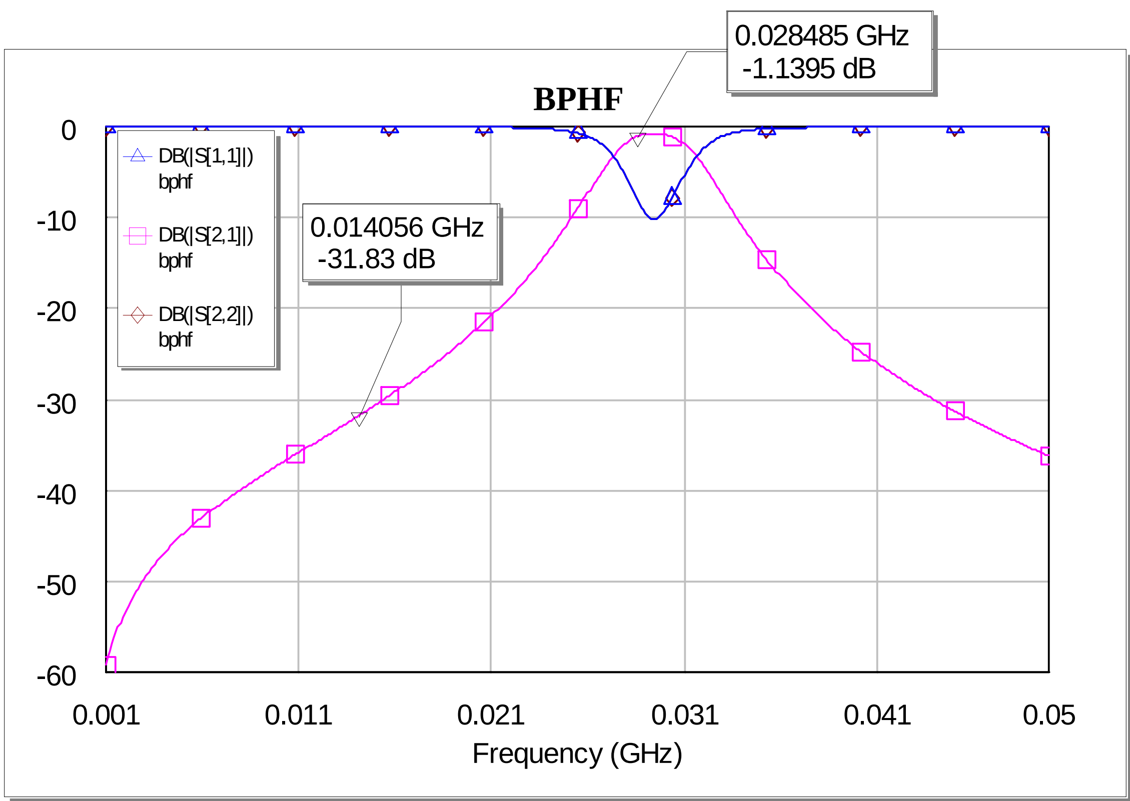
Ing Tasic Sinisa –Tasa YU1LM/QRP GQRP10091

At the beginning of 80 I worked with stations which have serious problems with IMD products such as FT101B, this was very noticeable on lower bands 7 ,3.5 and 1.8 MHz . In literature I saw very simple tunable bandpass filter designed by M. Martin DJ7VY in CQ-DL 7/84 which cure IMD problems substantially. Filter have 3 coils , double variable capacitors and few toggle switches for the frequency and bandwidth selection. Filter behaves as a tunable peak filer and insertion loss is changing very much with changing operation frequency from less than 1dB to 15dB. Bandwidth and selectivity is changing very much with operating frequency and because of that it was not suitable for use in transmitting systems. When you like to build HF bandpass filters especially for 50Ohm system problem is how to design them that the realization have to be a simple as possible. Without appropriate measuring equipments adjustment will be a nightmare especially with unknown coils or coils with taps. I designed simple tunable bandpass filter for whole HF and it is one of my favorite ***RF BRICK***-s for design on the table. It was designed and realized with the next design goal:

1. All HF frequencies (1.8-30MHz)
2. Insertion loss in range to max 3dB
3. Selectivity at harmonic related band in range of 30dB
4. input/output impedance 50 Ohm
5. coils with fixed inductance without taps

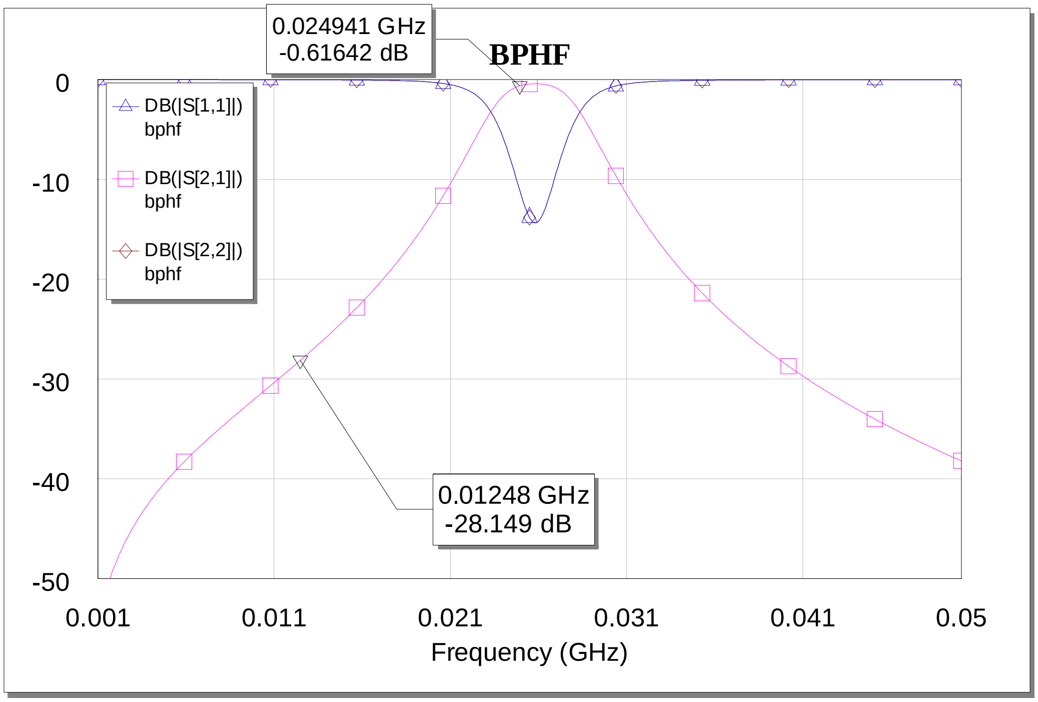
Tunable bandpass filter realization is very simple and compact made in one box based on PCB soldering ,it is important to notice that double variable capacitors(both connection) are isolated from the ground. Inductors are made with toroid core but I tried BP filter with fixed molded chokes and results are similar except little bigger insertion loss (see example diagram for filter 3.5 MHz). It is possible because working Q in banpass filter is small and sensitivity to component values is small too. It is possible to realized HF filter with only 2 coils (for example toroid T50-) with taps but it is not recommend for un experienced builders. Filter schematic diagram is at the picture below , toggle switches S3,S4 is possible to change with one SPDT with one neutral position. It is possible also to use fixed values for C and L to make filters according to given component values.



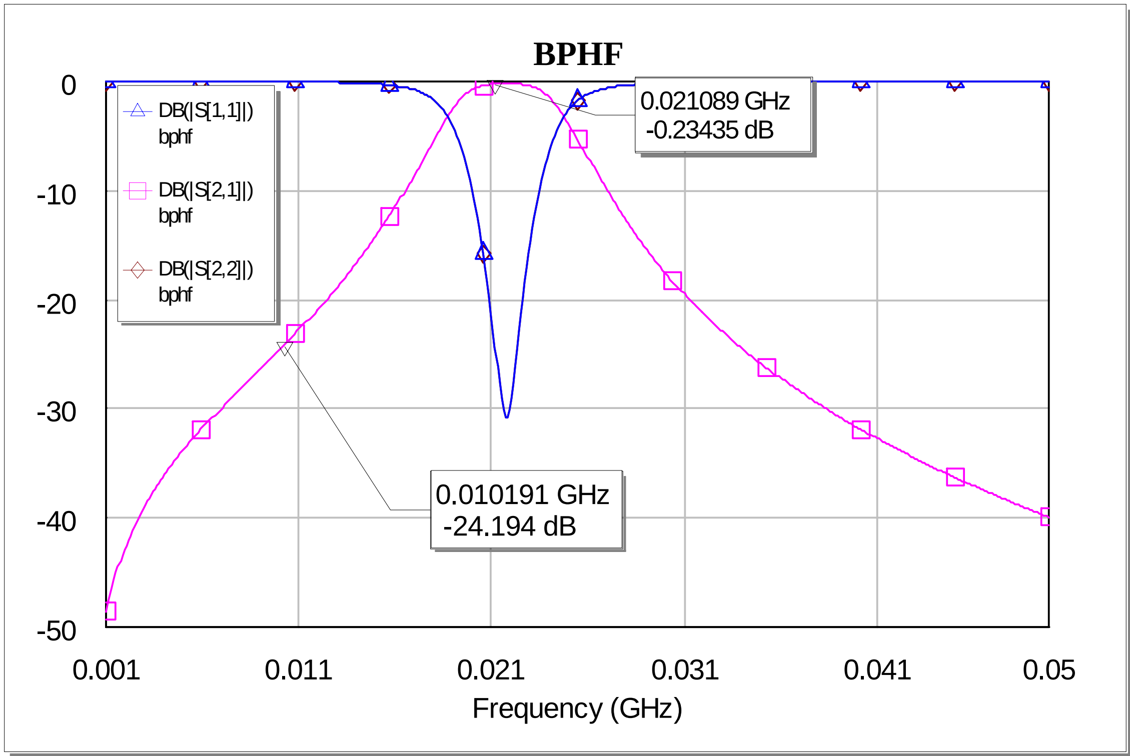


FILTER 28MHz
L=1.8uH Q=100

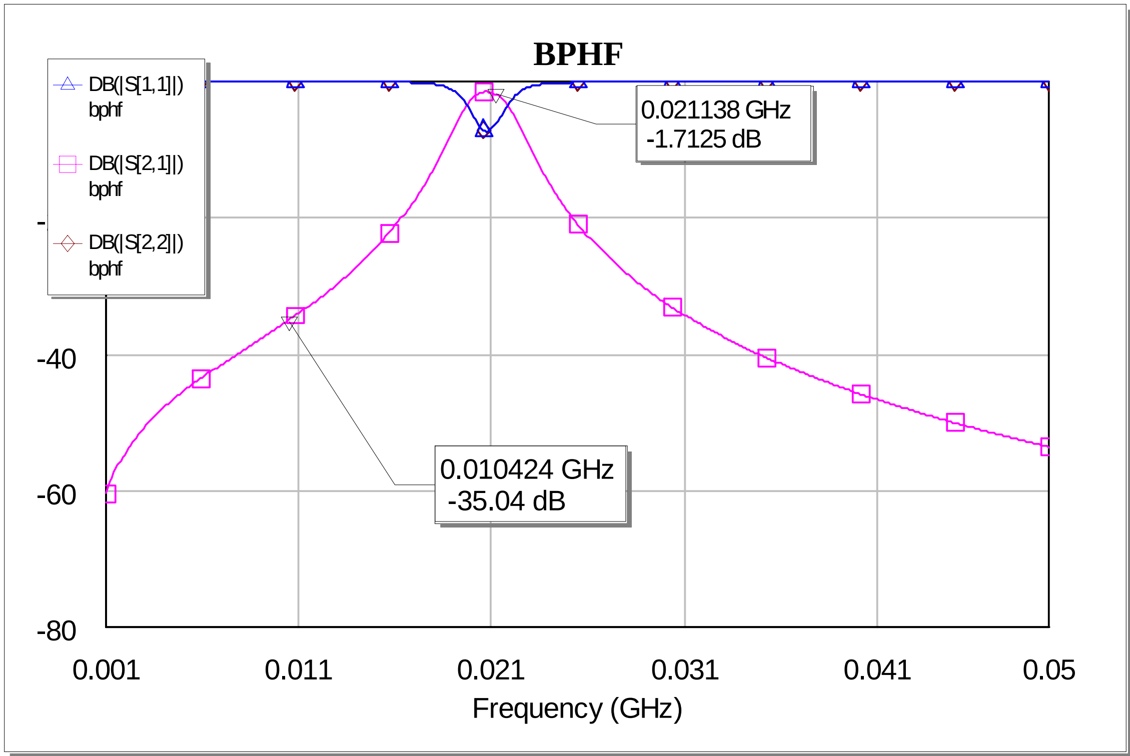
Cvar=20pF
C1=150pF



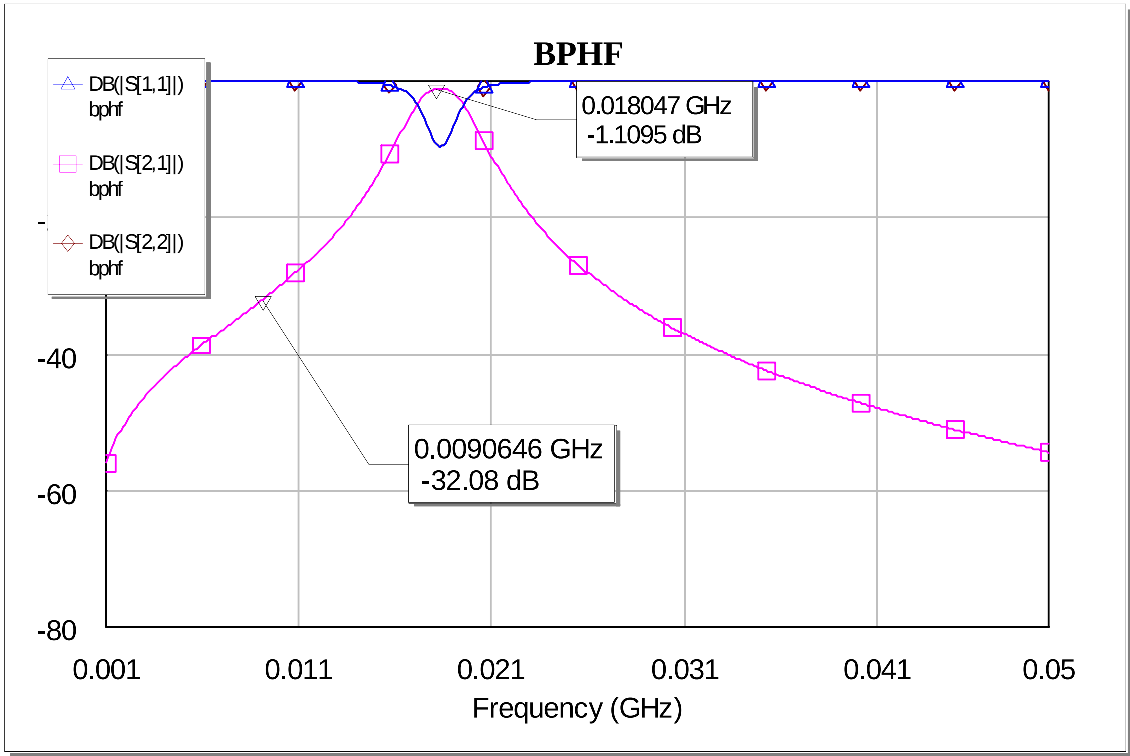
FILER 24MHz
L=1.8uH Q=100
Cvar=25pF
C1=150pF



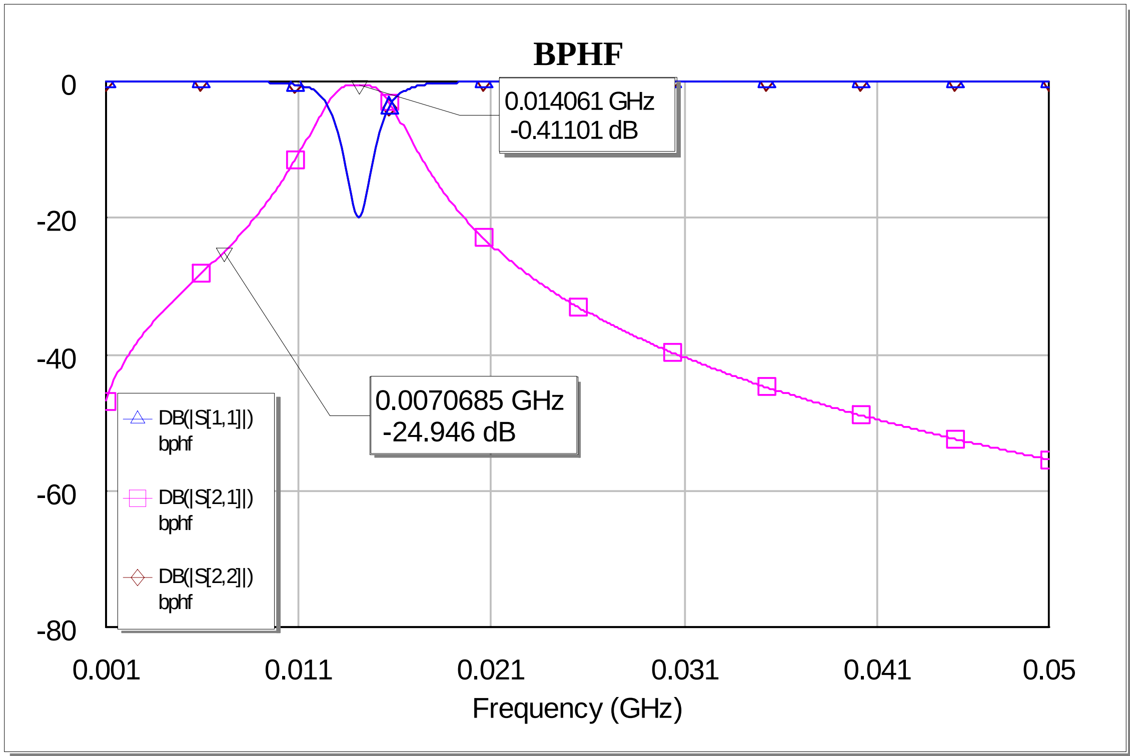
FILTER 21MHz
L=1.8uH Q=100
Cvar=36pF
C1=150pF



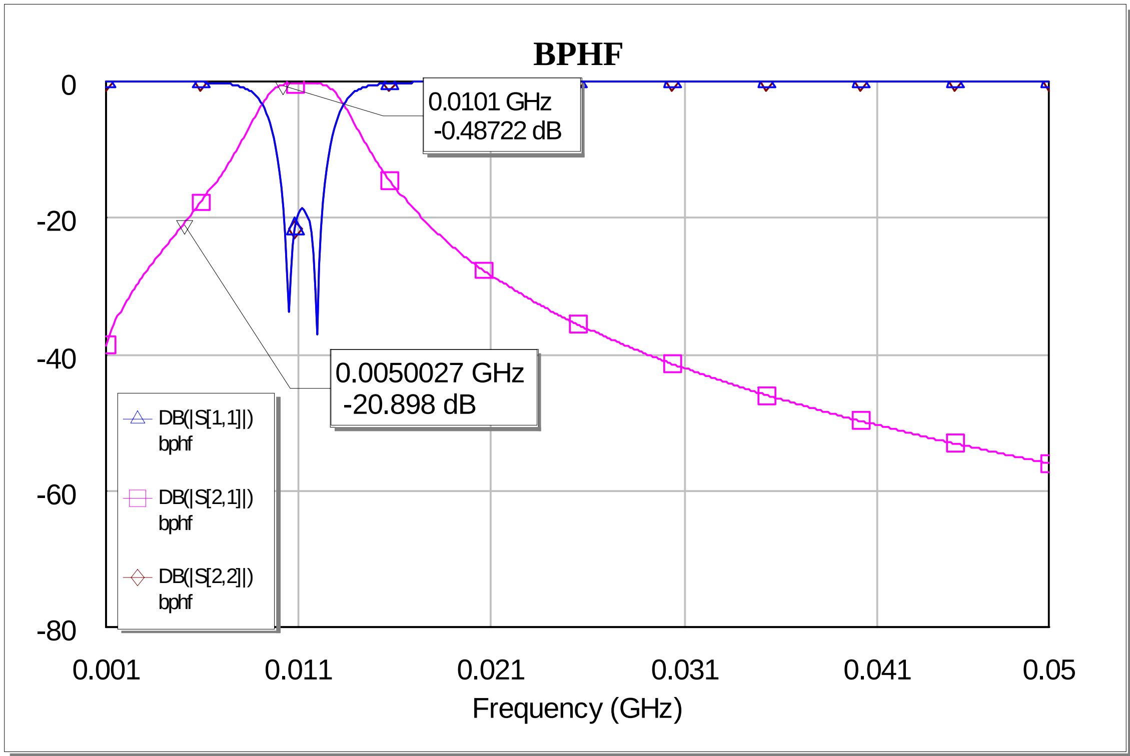
L=1.8uH+1.2uH Q=100
Cvar=21pF
C1=150pF+100pF



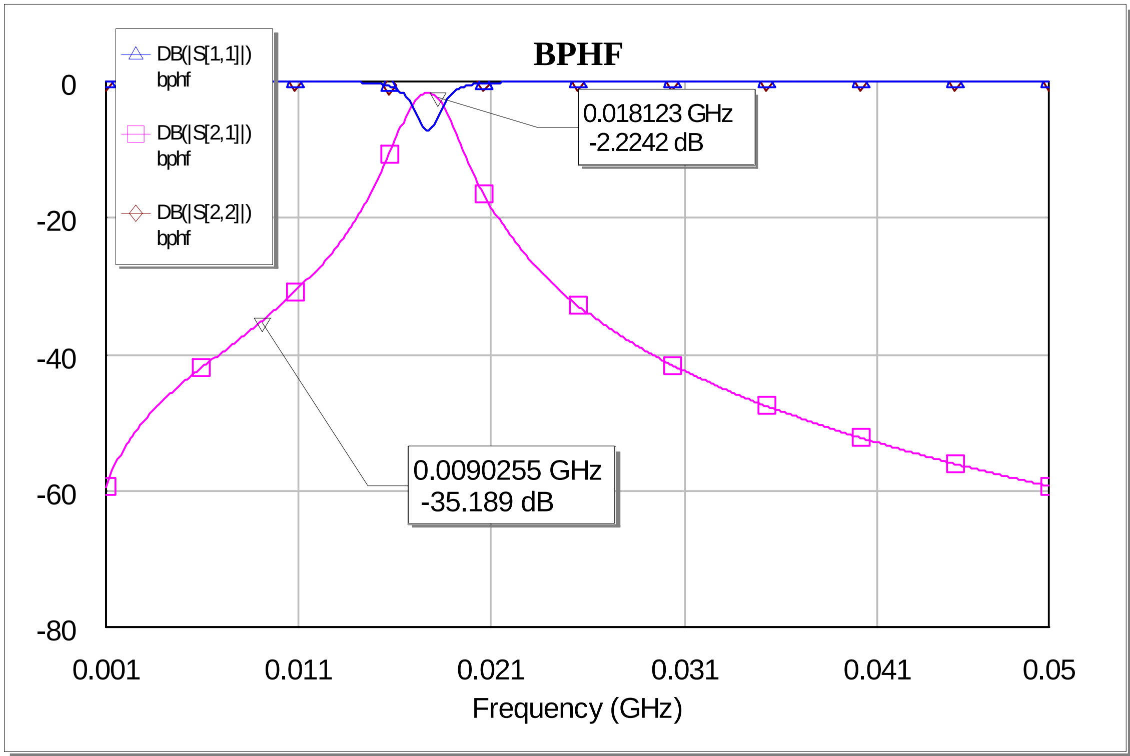
FILTER 18MHz
L=1.8uH+1.2uH Q=100
Cvar=28pF
C1=150pF+100pF



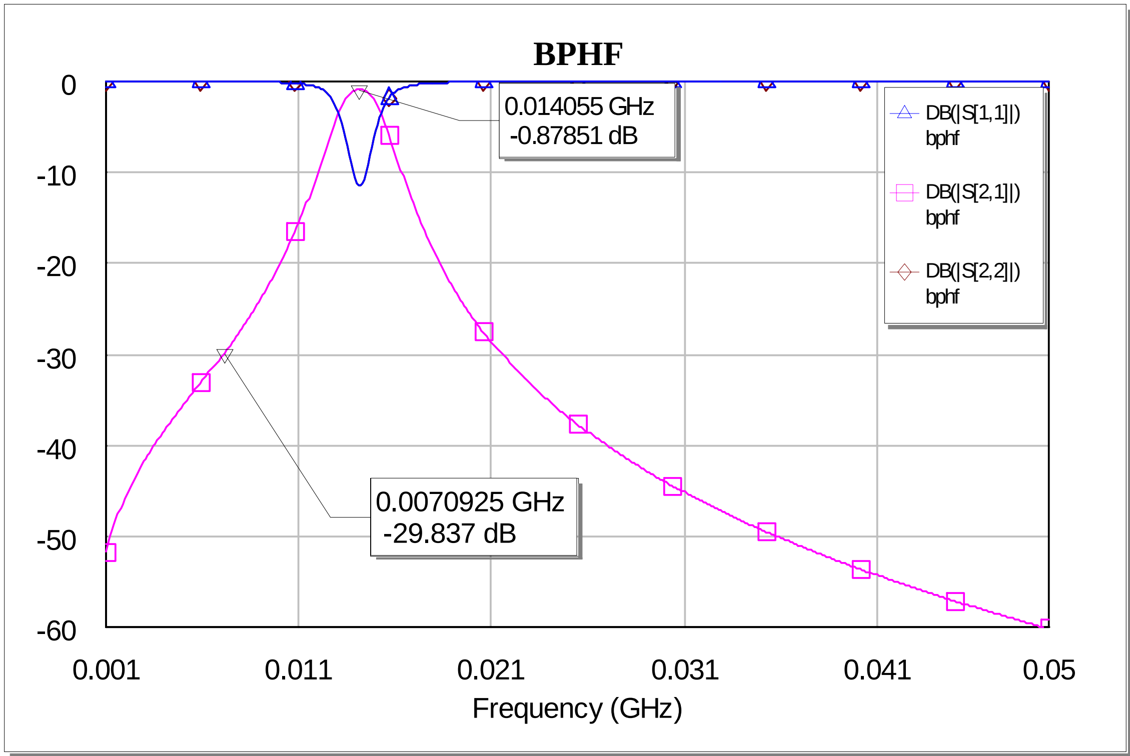
FILTER 14MHz
L=1.8uH+1.2uH Q=100
Cvar=50pF
C1=150pF+100pF



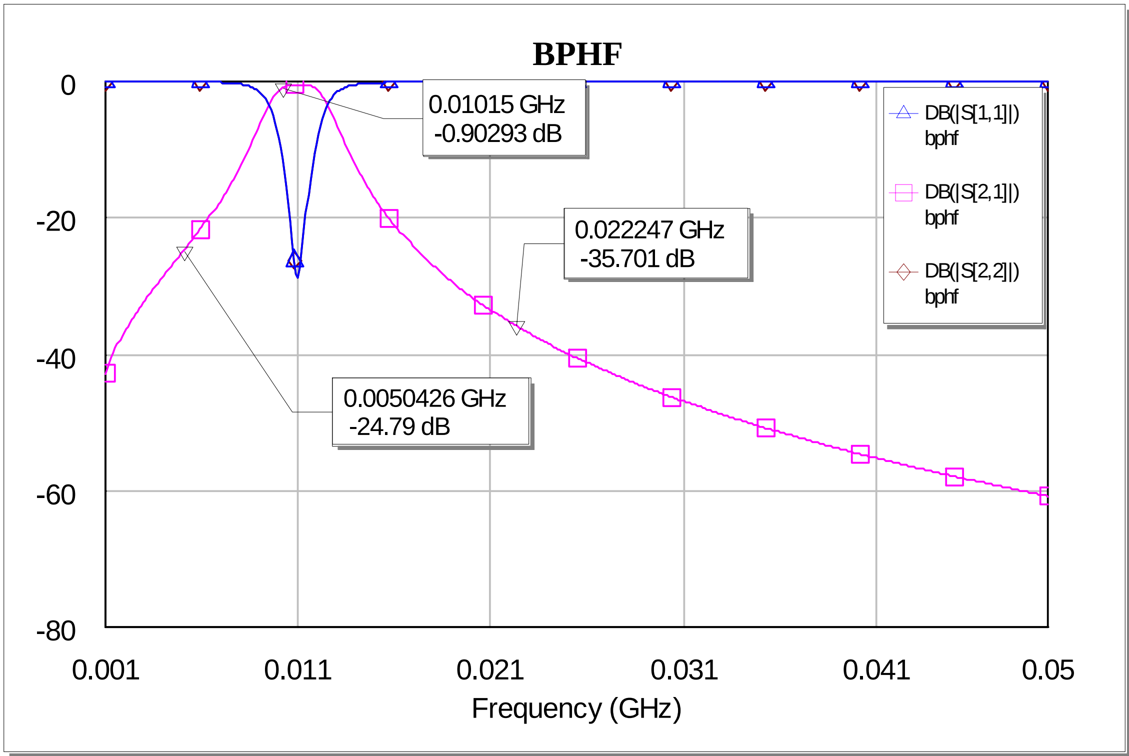
FILER 10.1MHz
L=1.8uH+1.2uH Q=100
Cvar=88pF
C1=150pF+100pF
Alternative value



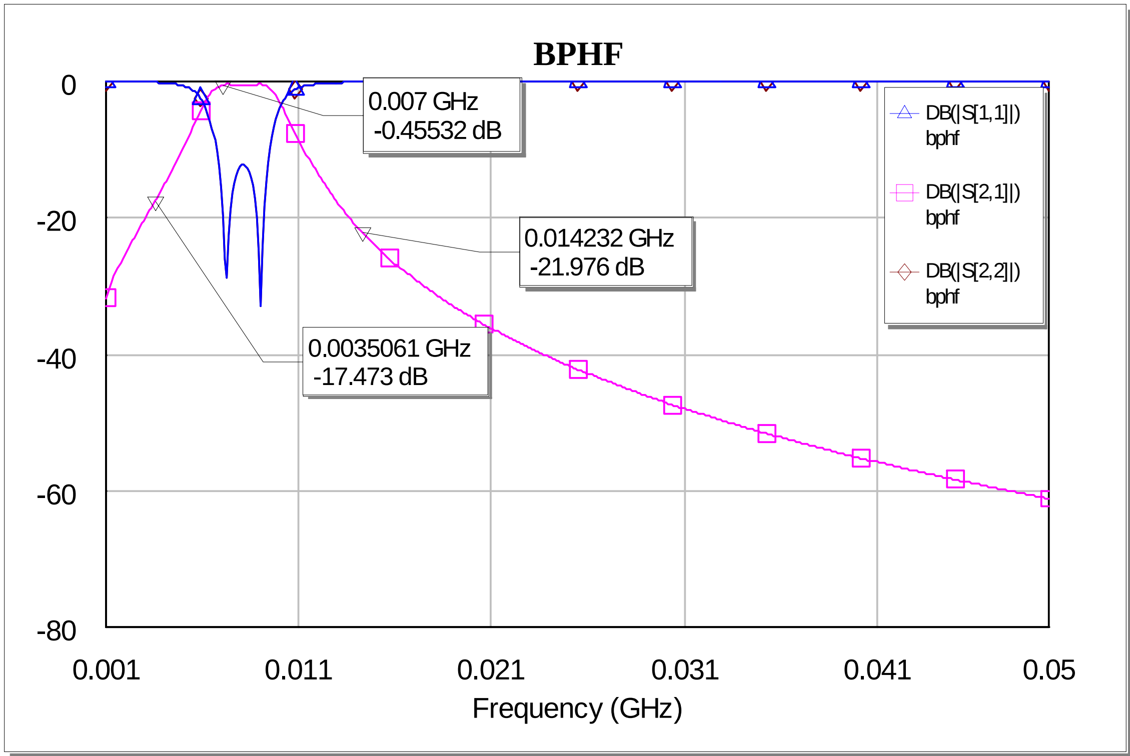
FILTER 18.1MHz
L=1.8uH+1.8uH Q=100
Cvar=24pF
C1=150pF+150pF



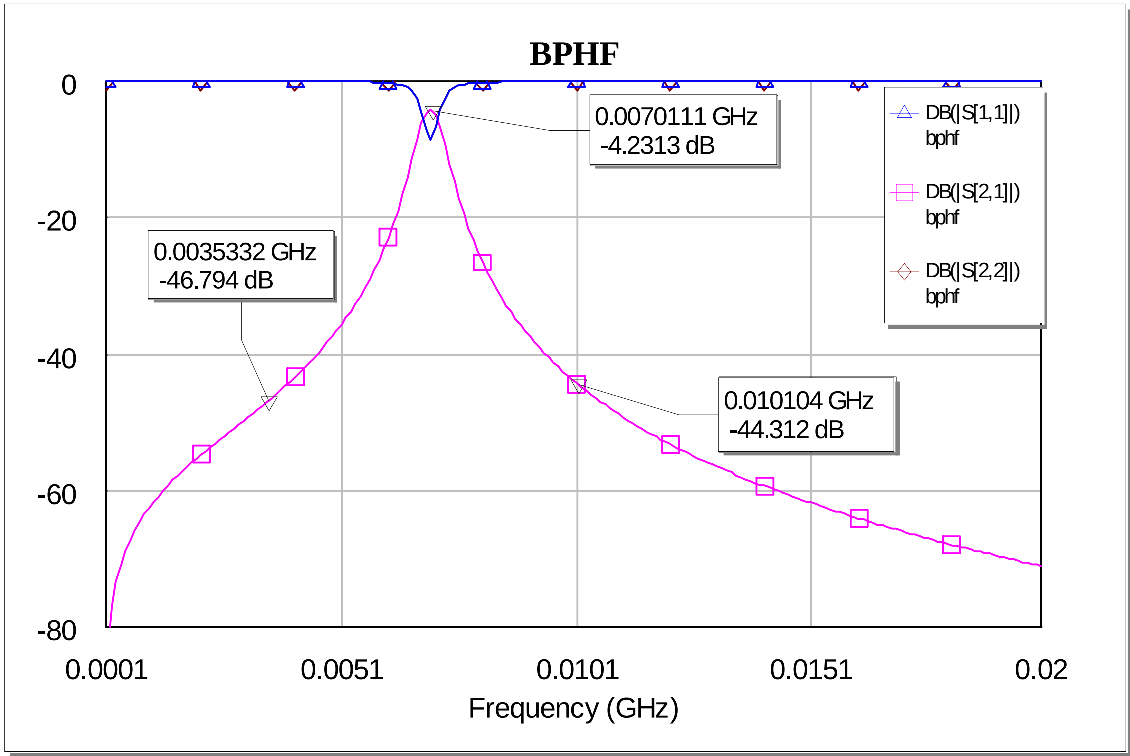
FILTER 14MHz
L=1.8uH+1.8uH Q=100
Cvar=39pF
C1=150pF+150pF



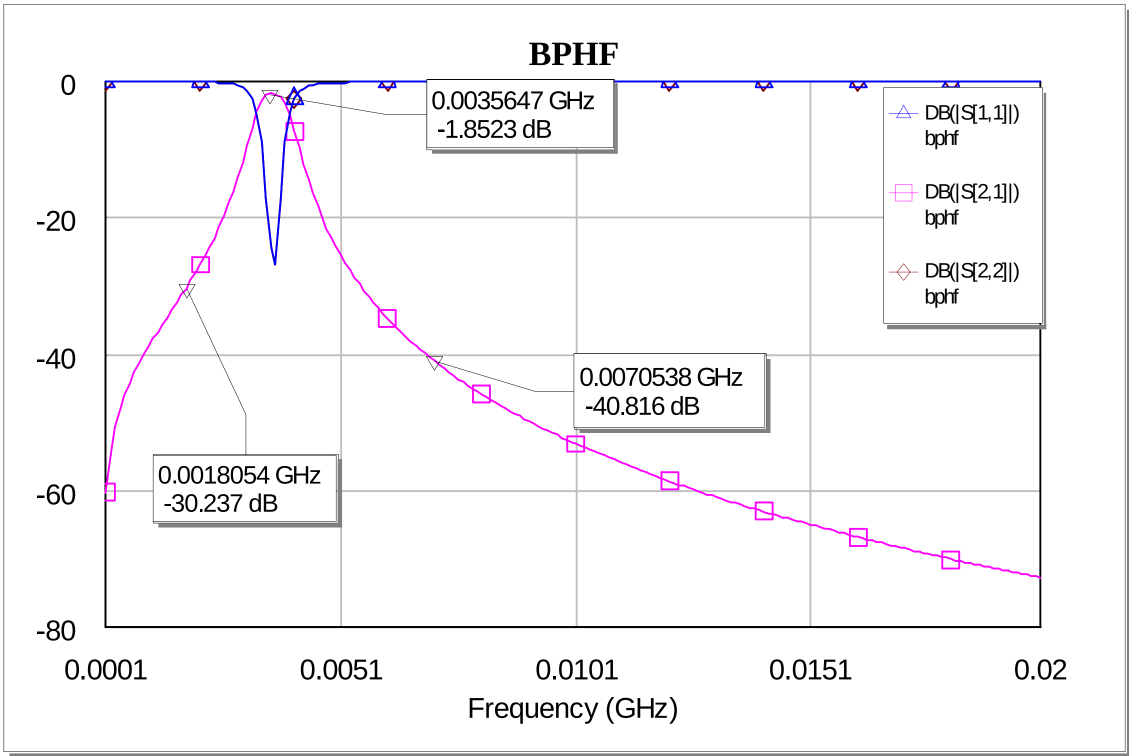
FILTER 10.1MHz
L=1.8uH+1.8uH Q=100
Cvar=70pF
C1=150pF+150pF



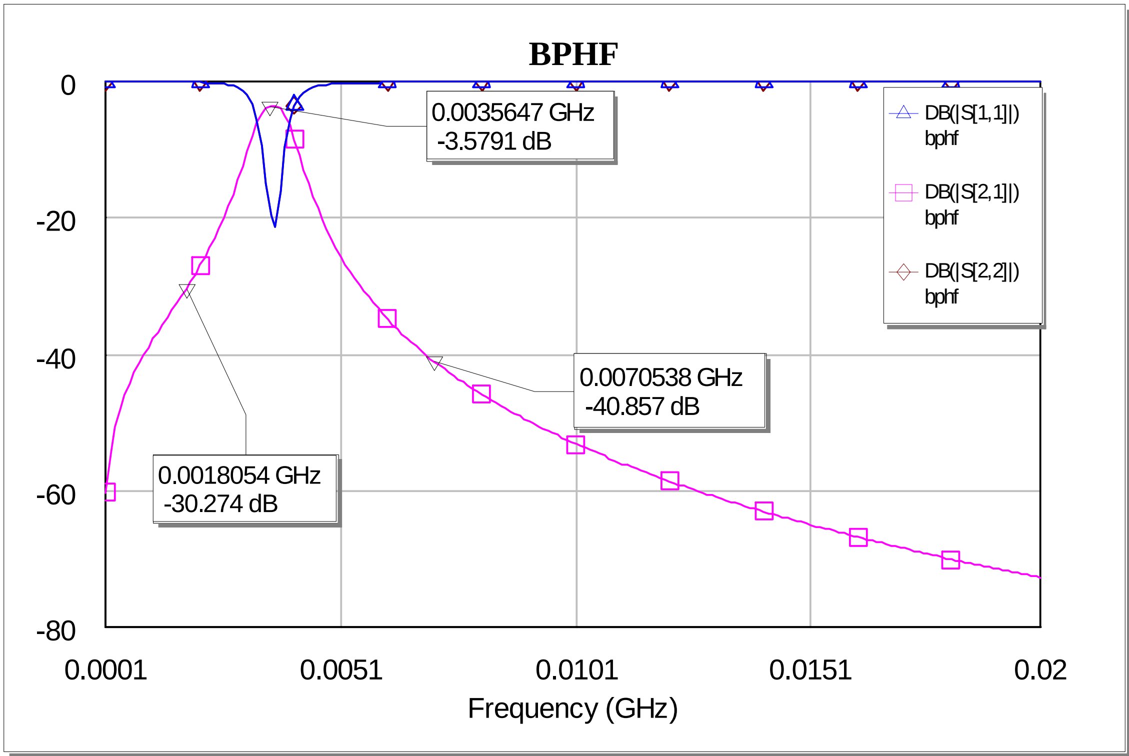
FILTER 7MHz
L=1.8uH+1.8uH Q=100
Cvar=155pF
C1=150pF+150pF



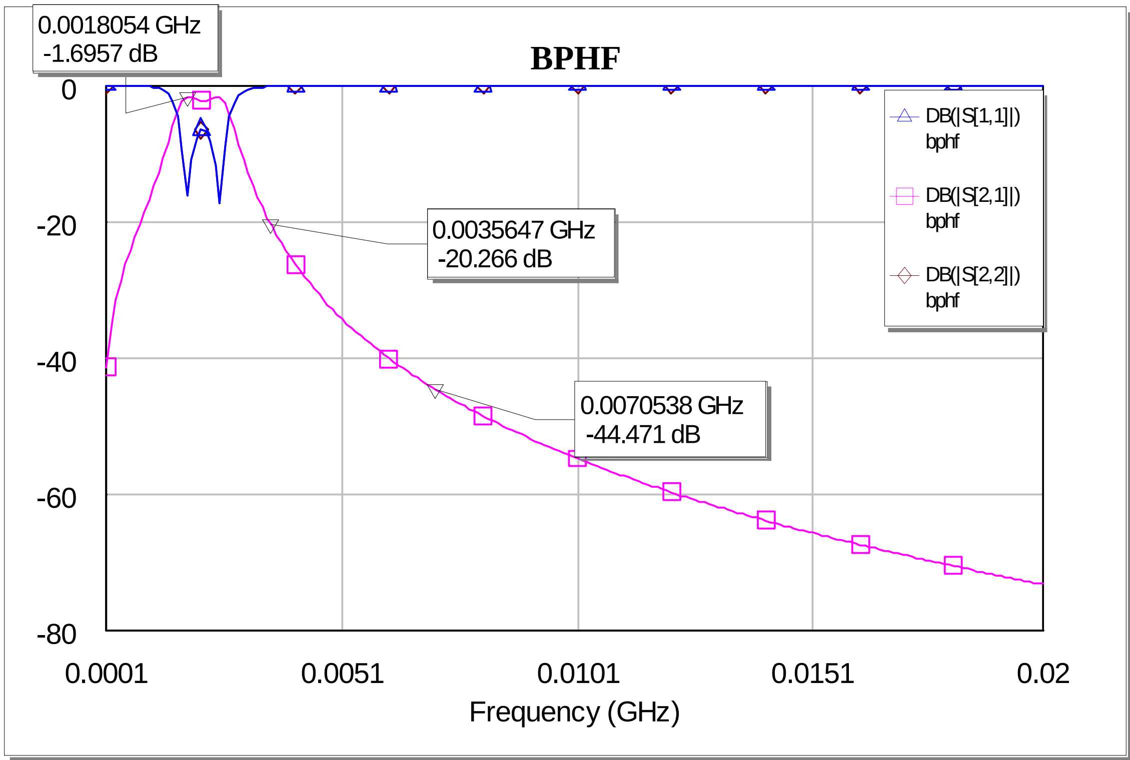
FILTER 7MHz
L=1.8uH+15uH Q=100
Cvar=32pF
C1=150pF+680pF



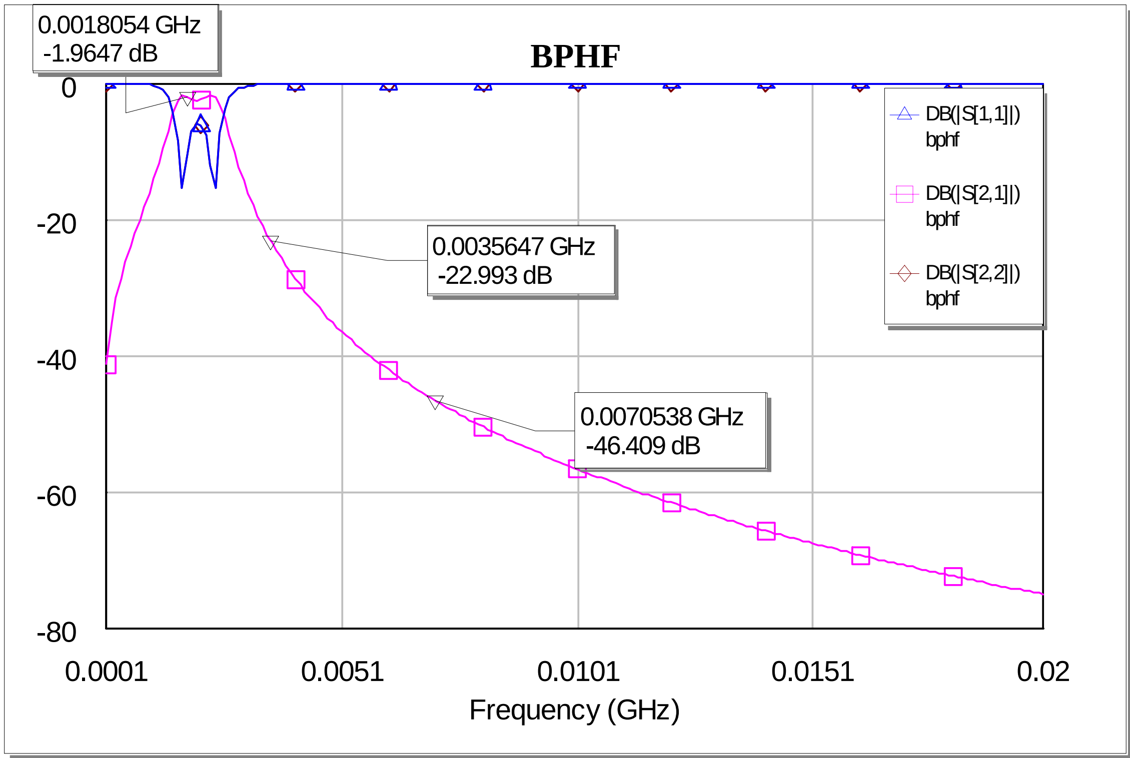
FILTER 3.5MHz
L=1.8uH+15uH Q=100
Cvar=130pF
C1=150pF+ 680pF



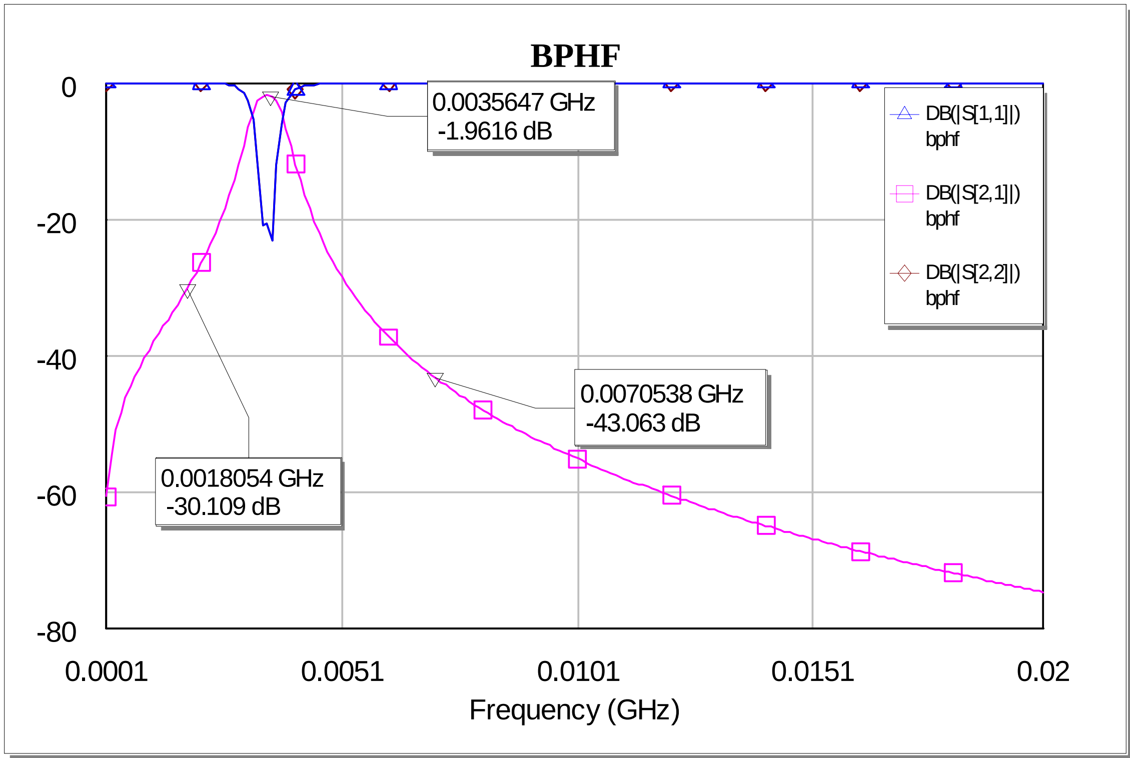
Filer for 3.5 MHz same as previously but Q=50 typical value for molded chokes



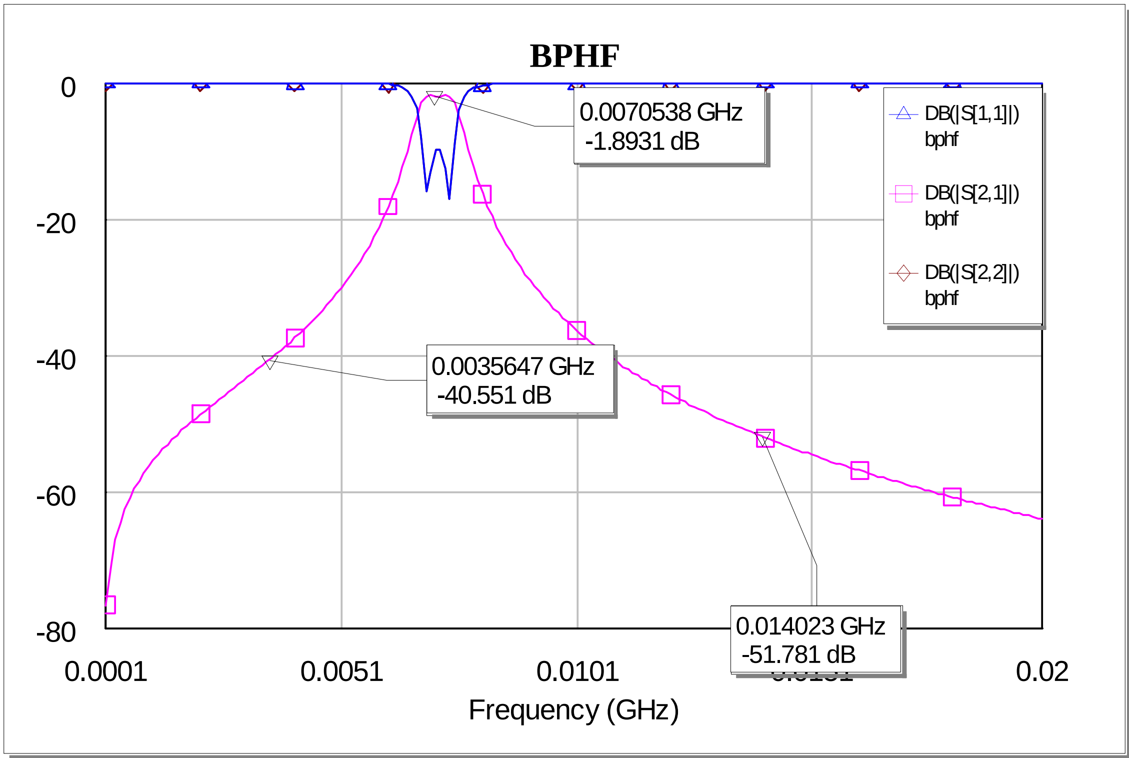
FILER 1.8MHz
L=1.8uH+15uH Q=100
Cvar=500pF
C1=150pF+680pF



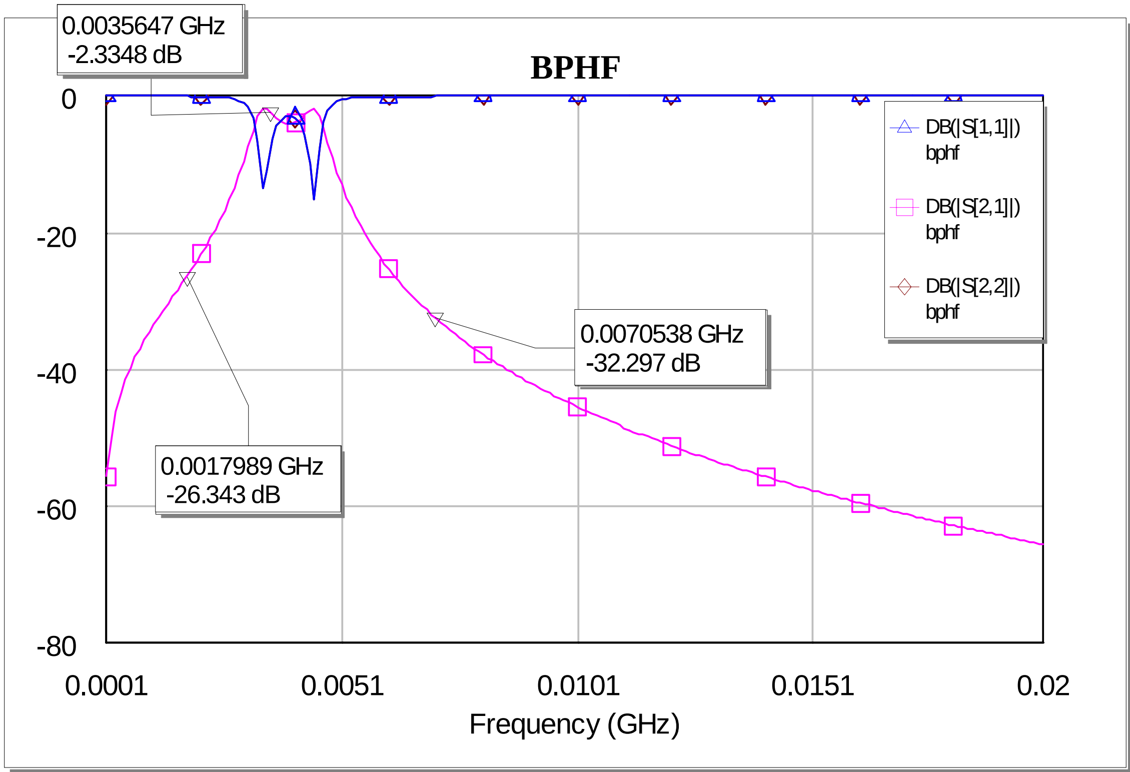
FILTER 1.8 MHZ
L=1.8uH+1.8uH+15uH
Cvar=500pF
C1=150pF+680pF



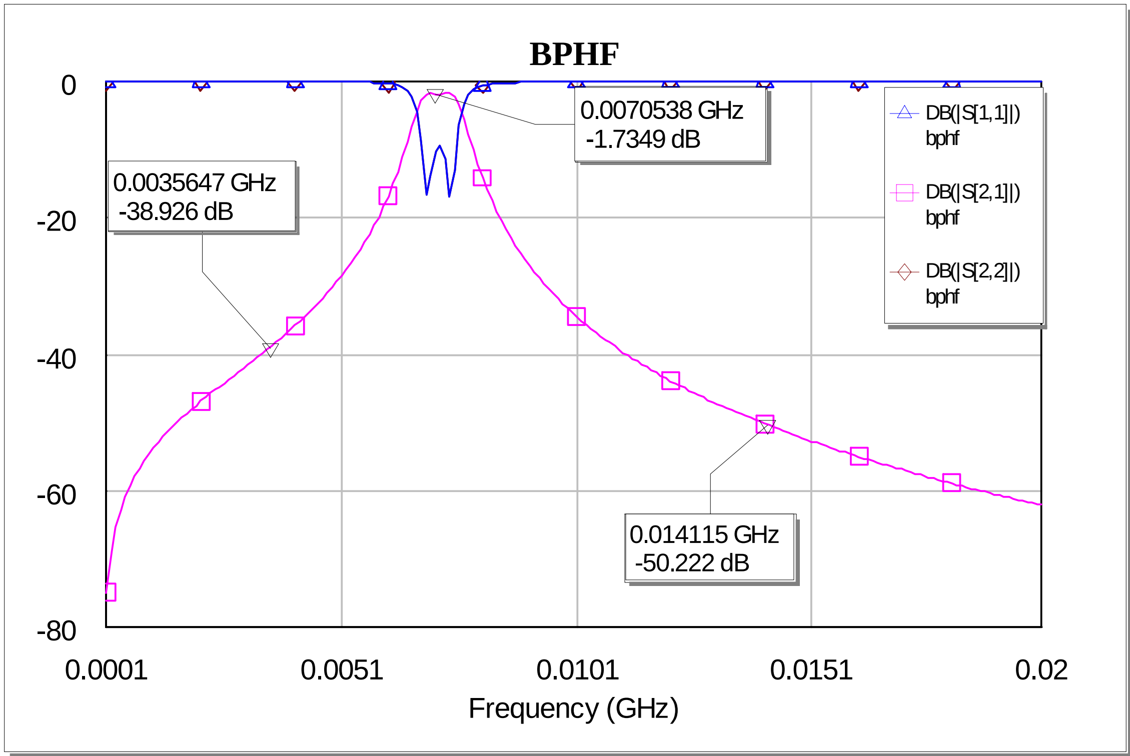
FILTER 3.5MHz
L=1.8uH+1.8uH+15uH Q=100
Cvar=127pF
C1=150pF+680pF



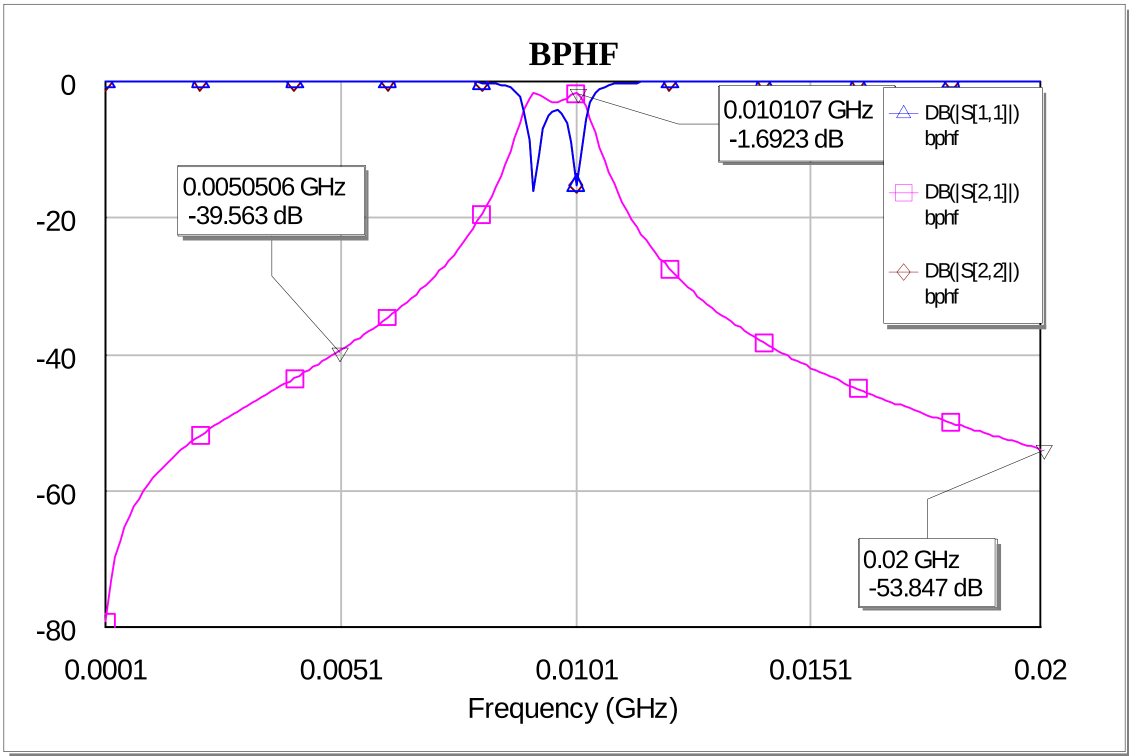
FILTER 7MHz
L=1.8uH+1.8uH+15uH Q=100
Cvar=29pF
C1=150pF+150pF



FILTER 3.5MHz
L=1.8uH+1.8uH+15uH
Cvar=118pF
C1=150pF+150pF



FILTER 7MHz
L=1.8uH+15uH
Cvar=32pF
C1=150pF+150pF



FILTER 10.1MHz
L=1.8uH+15uH Q=100
Cvar=18pF (some variable capacitor can reach this value)
C1=150pF

HAM Sample and Hold SDR (Software Defined Radio) Receiver for SSB ,CW ,AM ,FM, DRM..On HF (30 kHz to 70 MHz) in Connection With PC Sound Card– Make it Simple as Possible with Outstanding Performances –Part 1

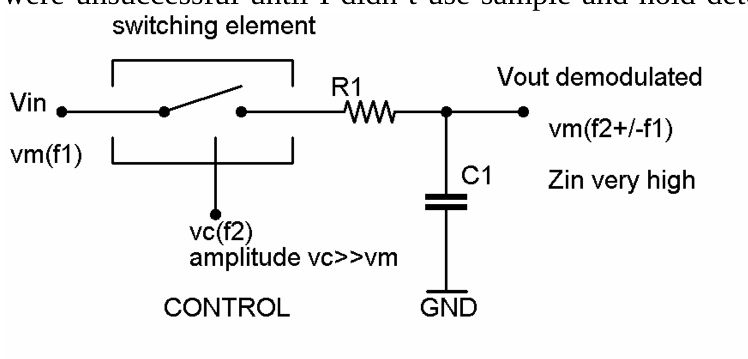
Dipl. Ing Tasic Sinisa-Tasa YU1LM/QRP

I touch my dream. Probably you are asking what I am talking about. I am HAM for more than a 35 years and professional RF designer near 25 years. My dream, for the all this years was to make receiver and later transmitter design for HF to 50-70 MHz simple as possible without any real RF parts few coils Xtal filters…Of course all with very good specifications high IIP3 and very big SFDR . With great technology progress and PC powers this dream is near to be finally realized. Did you ever build HF receiver 30 kHz to 70 MHz without any coil and that it work exceptionally? You are thinking that isn't possible probably but answer is that it is possible and answer is here in the articles This project is part of my try to made SDR transceiver for HF HAM bands in connection with PC sound card and PC DSP processing .Everyone who try to make DC (direct conversion) receiver knows how hard it is to build receiver with good opposite side band rejection or very sharp clear sound and changeable sharp bandwidth filter. Try this in field of mathematical calculation you will realize that is everything much easier but you have to be educated with much sophisticate knowledge to do it. This is series of three parts, three articles are:

Parts 1 very simple receiver DR1 without image rejection receiver very simple but good start with the SDR receiving. This receiver was discovery for me and I spent a lot of time in testing and listening with it in different circumstances. It can be realized for the very short time for the one afternoon and it is very cheep. Present of image are not a big disadvantage like in DC direct conversion receivers but something about that later. This receiver can be used as a second or first IF in receivers after crystal filters which very easy reject unwanted image also. As demodulator it is far superior to the all other types common used demodulators in practice. I never didn't measure S/N ration in HF CW receiver 80 dB before it. DR2 is also very simple and very good I/Q HF receiver frequency are limited to the 30 - 35 MHz with built in components.
Part2 DT1 DSB modulator for frequency from 30 kHz-70MHz with very good linearity and DT2 SSB/CW or any other modulation SDR HF low power transmitter which can be generate with I/Q signals.
Part 3 SDR HF receivers DR1A (Advanced) similar to the DR1 but with improved specifications the same situation is with DR2A improved DR2

DR1 is one of version receivers which I tested first and a lot of time and which working really good or I can say better fantastic. I shall describe practically realized receiver with fixed oscillator in reason of simplicity but it is very easy keep on receive all other HF frequency with adding VFO (for example based on DDS chips like AD 9850, AD9851, AD9854… or some other local oscillator) You can find a lot of solution on INTERNET for the VFO (at the end is a big list sites for this subject reference 4). This project is similar in some aspects to the Gerald AC5OG SDR1000 design but it is a much simpler... I suggest all who want to understand better SDR radio subject to read excellent articles from Gerald AC5OG (reference 2) and well known VHF/UHF designer Leif SM5BSZ (reference 3).

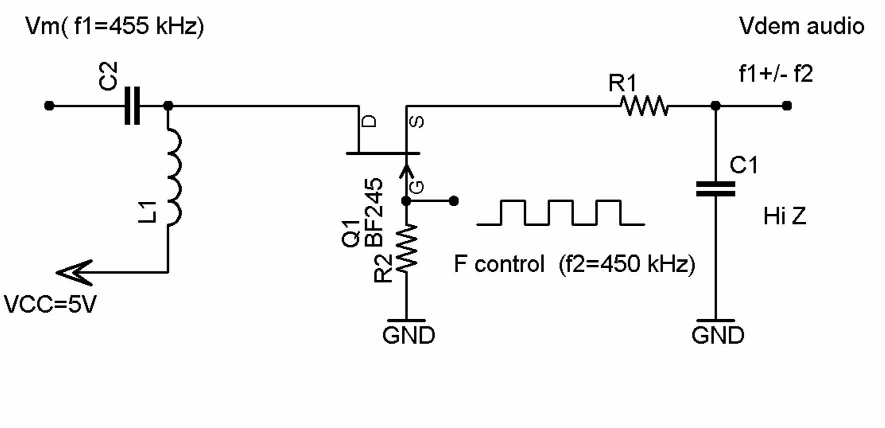
Let's start from the beginning. In the late 80's I have professional task to design detector for the some linear modulations with extremely small DC offset. All my trays were unsuccessful until I didn't use sample and hold detector see below which is really



SAMPLE AND HOLD DEMODULATOR

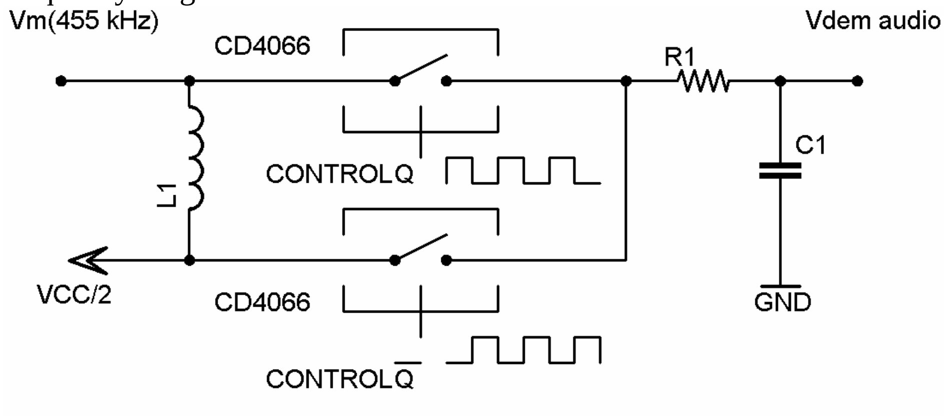
very simple.

I try to make it at last IF of 1 MHz but FET which I used U310….. didn't work well I try some other DG… switchers and at the last I tried CD 4066.

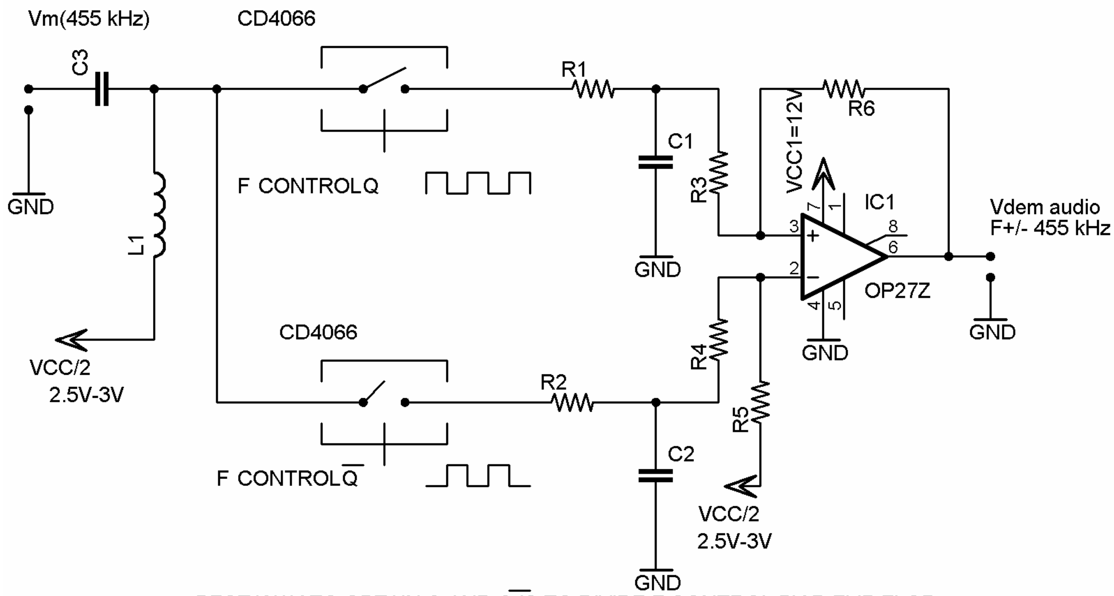


Sample and hold demodulator realised with JFET

Final solution was with CD4066 which worked at new IF 300 kHz and enabled me extremely linear work in connection with AD converter. Sampling capacitors with resistance of switch worked as LP (low pass) filter and it was really easy to make anti aliasing filter before AD. Also FET was working well at this frequency. As HF HAM I tried to use this for amateur purpose but it worked very badly when I passed over 1-2 MHz. When Dr Ulrich Rohde published article reference 5 I remembered my previously work and tried solution but I made change which is the base of the mine later design. At that time YU land was under embargo and I tried solution with CD4066 which was available in that moment. IC CD4066 except good work has still limits with useful frequency range.



Simplified demodulator U.Rhode from reference 5



BEST WAY TO OBTAIN Q AND Q IS TO DIVIDE F CONTROL BY D FLIP FLOP
F CONTROL HAVE TO BE 2*F AT THE INPUT OF D FLIP-FLOP

DEMODULATOR CIRCUITS MODIFICATION FROM REFERENCE 5 BY YU1LM

When I read in reference (6) article of use 74HC4066 as HF mixer I was delighted. I tried mixer in DC (Direct conversion) receiver but as it was done in original article. At that time I had professional task to design DC receiver with very big DR (dynamic range) and I was designed better post detector amplifier then it was in the R2 famous design from KK7B. Now I mixed this two design and I made DC receiver which is working really good I shall publish this design latter if it interesting for builders.

I like contests and competition very much and I took part in many of them. I am really QRP op you can see my call in many contests and score lists I am using big multiband horizontal loops 84m and 168m. Signals from loop are really test for the receivers big challenge with a lot of signals from wanted and unwanted frequencies. I am using ICOM 725 readjust for the QRP work and it has an improved RX performances as it is described in the QST and some additional mine improvements. I decided that for new homebrew receiver use 74HC4066 because it was much easy to obtain than FST… chips and I had a lot of normal classical size components (not SMT). I designed RF front end according to the W.Sabin ideas published first in Book Single-Sideband Systems & Circuits page 96-103 after that published in RadCom .Very similar is realization from Oleg Skidan UR3 IQO in his famous T03DSP transceiver reference 1. It is front end with 74HC4066 mixer without RF amplification before roofing filter. I tested front end and it works very well from very low frequency to the 70MHz where IL (Insertion Loss) grove up from 5.5-6 db to 7 dB. IIP3 was around 30-35 dBm what is really good results for this cheep and easy obtainable component. After roofing filter I inserted IF amplifier with very big DR (dynamic range) and gain of 22 dB and AGC circuit with PIN diodes which after new crystal filter feed demodulator. I tried few solution for demodulator as it is in original AC5OG papers but with 74HC4052 which is also 1-4 multiplexer and it is also recommended from Leif SM5BSZ. I was disappointed with results because useful bandwidth going up to the 10 MHz. It works in receiver as IF 9 MHz demodulator circuits but I wasn't satisfied with it to the end. I tested SDR receiver first time with software from DL6IAK ref 7 and after those with others freeware software. Basic idea for design was to simplify RX hardware design and to make bigger use of PC in receiver realization. I looked once more to the different articles and some my papers and find my solution from 1993 as variation of article 5 and changed CD series with 74HC series 4066 and I was really surprised with this "dead bug" construction can do. To speed up testing I used demodulator as SDR receiver connecting to the antenna for the first moment. I connected my big loop through 7 MHz band pass filter and results from these simple circuits were really unbelievable. Surprisement kept on when I adjust my DDS synthesizers to 3.5 MHz and for the quick test I missed any BP filters. It was during one contest and I couldn't believe. No noticeable IMD (intermediations) or sign of any overload when I back to the 7 MHz with a loot of very strong broadcast stations all without any filters try this test with any other mixer or demodulator.

I easily copied very weak station in presence of strong I used mainly software for SDR receivers from Alberto I2PHD and I tested other freeware software ref 1,2,3,4,5…..thanks boys for your big job and effort to share your work with all others.

I2PHD software enable me great flexibility and I listened a lot of HAM and commercial stations without problems. Also all other freeware software working similar but it is evident difference in results and flexibility. Software made by Vittorio IK2ZCL also gave very good results it enable the most pleasant listening but it take some time to adjust (it is for fixed audio frequency).When next week my neighbor YU1KR start competition with his HP (high power 1KW) station and 3el beams in my direction distance between us is around 350m by air. I noticed first time noticeable IMD harmonically related to the its demodulated audio LF(Low frequency) .Check with oscilloscope gave me evidence that post demodulation low noise amplifier OP027 generate IMD because of low side clipping. Output swing for OP AMP is different with single power supply and it is hard that it arrive to the zero (0)V. Useful output is for this simple schematic 2Vp-p at the output with power supply 5V for digital circuits. If you like more dynamic made change power supply with 6V Voltage regulator and than output swing will be near 3Vp-p 6V speed up dividers and lower ON resistance and it is max for 74AC74. I measured demodulated signal from YU1KR. It was around 0 to -5dBm and with 20dB amplification from OP it is too much big signal for OP AMP my sound card was Realtek AC97 in my lap-top. Because of that I put 15 dB attenuator between sample and hold detector and antenna. Now it was possible to listened very weak station 3-5 kHz away easy and there wasn't evidence of clipping OP. I compared these results with some other design see presentation renaissance of DC receivers current receiver DR1 is without audio image rejection and it was superior very much too all other very good DC (direct conversions) receivers designs R1 ,R2….etc. There is no sign of gargling sound (not clear sound) hum or microphone tendency characteristic for DC receivers when we have a lot of gain or when we reduce available bandwidth to few hundred Hz or less. Listening with DR1 was really music for my ears. I am using headphone always, with it is much easier to notice all potentional problems in receiving chain than with loud speaker. Measured results, mainly done with Alberto I2PHD SDR receiver, are:

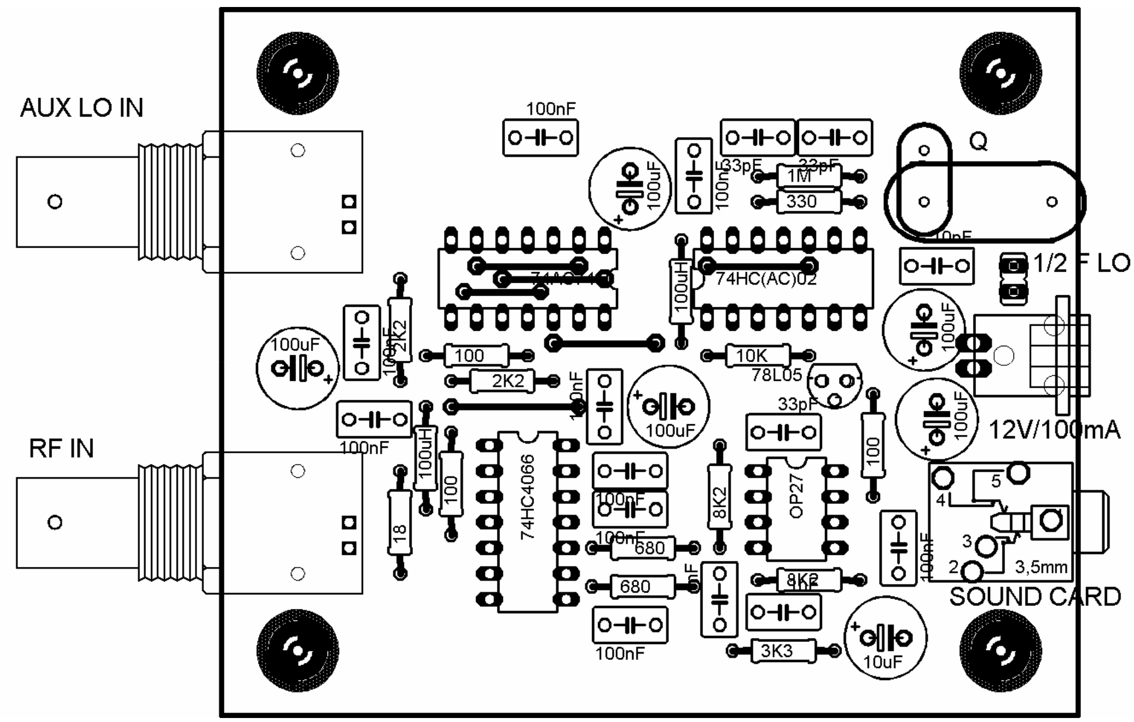
1. Receiving range from 30 kHz to 70 MHz (with Q oscillator it is limited to 15 MHz with one xtal Q 14.318 MHz you can receive 7.169 MHz and 3.575MHz ..Oscillator working with C2,3=33pF between 2-20 MHz for other change C2,C3)
2. IIP3 28-33 dBm it depends from setting and used programs (all with 16 bit sound cards). Max measured IIP3 with only 3 dB AF gain is 38 dBm but with reduced sensitivity
3. MDS 102-105 dBm
4. Sensitivity 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 80 dB (result hard to obtain with any other only hardware HF receiver). This sensitivity is more than enough for frequency near 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain or putting some RF preamplifier in front of DR1 to lower F (noise figure) of receiver.
5. SFDR (Spurious free dynamic range) is 88-92 dB, this results are with signals spaced 2 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more. All measurements are done by use HP8662 signal generators and HP 70000 series spectrum analyzer. See same specification for the some very expensive HAM Rig.

These results are really very good for receiver from only “two or three” parts without any resonant circuits completely audio design HI!!!! Some excellent performances are not without other side.

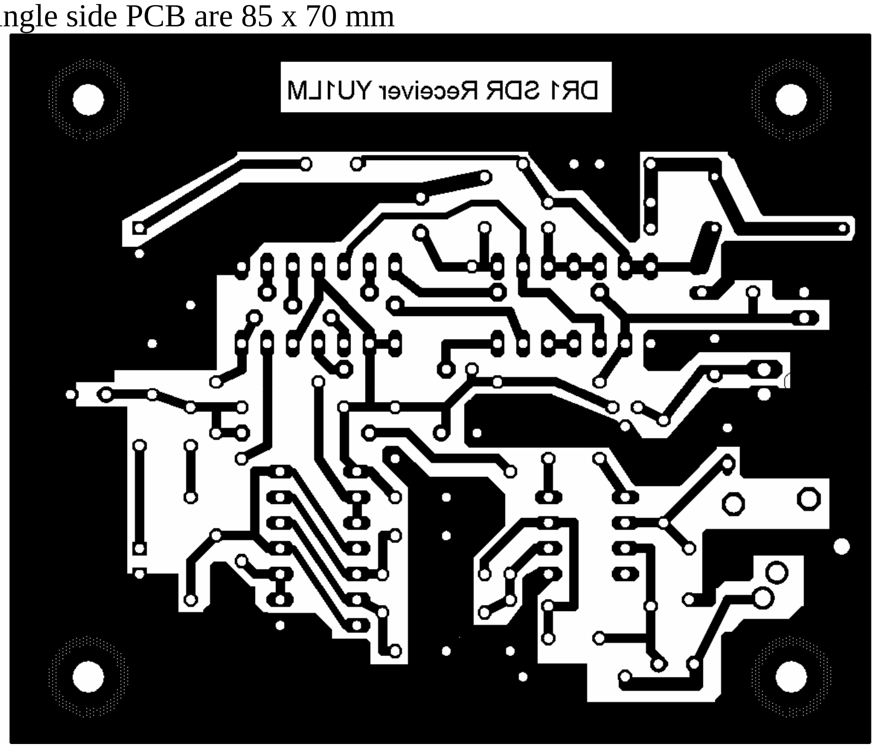
1. First and very big disadvantage for potentional builders are twice (2) higher frequency for LO (local oscillator)
2. Receiver has an audio (IF) image and it is disadvantage in crowded bands but my practical experience with external LO and changing IF in PC sound card talking to me that it can help to minimize problems of unwanted receiving. One little trick for HAM bands is to use LO exactly at the beginning off band 2 x 3500 kHz …… Out band signals are very often very rarely Listening broadcast station and DRM station was also very good. Image receiving is problem in case two same strength station. I was capable to receive a lot of broadcast stations with only half of meter wire antenna. If you want to receive weak station it is necessary to put preamplifier in front of DR1 for short receiver

antenna is very good JFET preamplifier you can find a lot of realization on sites devoted to DRM receiving.

3. Useful bandwidth is only 20 kHz in SDR PC receivers and 48 kHz sampling rate there is no other branch like in second receiver DR2 (better sound card wide band and better spec). Here is my single side PCB for DR1:



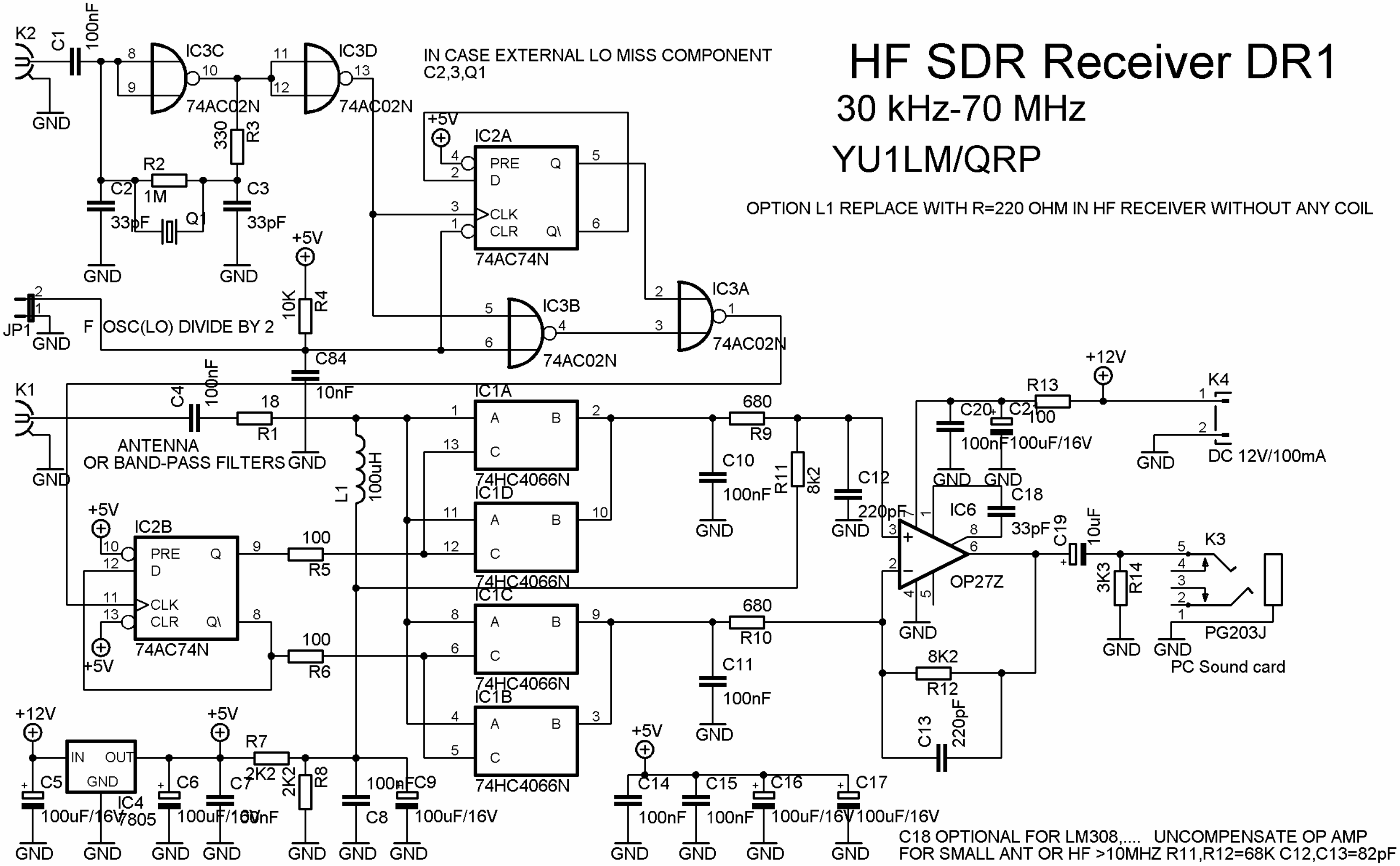
Dimensions of single side PCB are 85 x 70 mm



HF SDR Receiver DR1

30 kHz-70 MHz

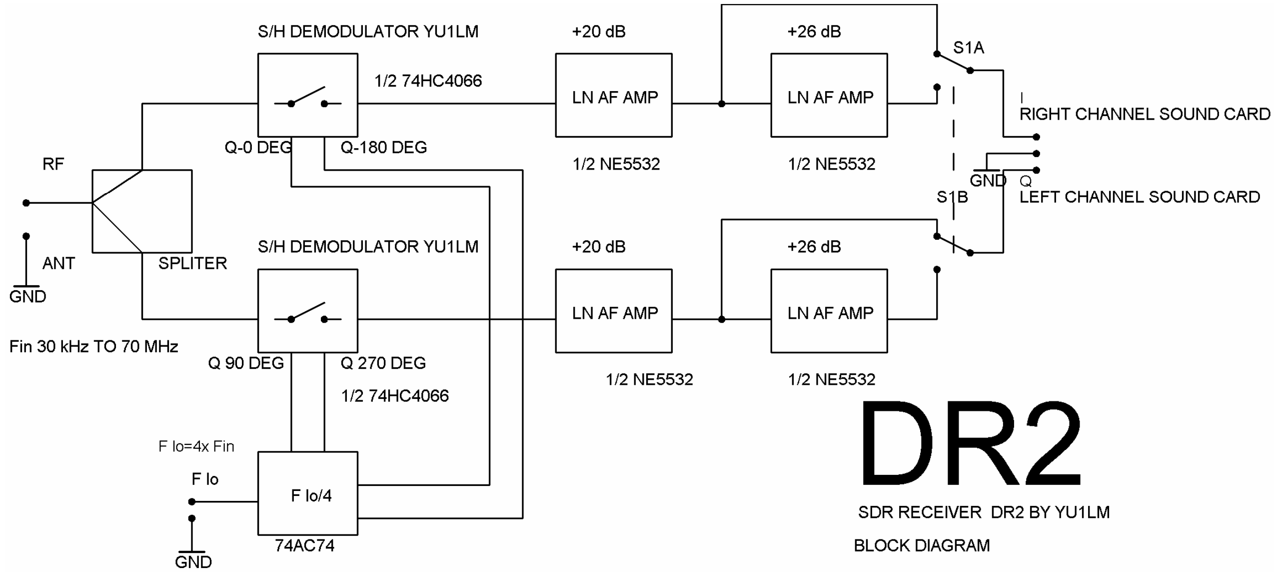
YU1LM/QRP



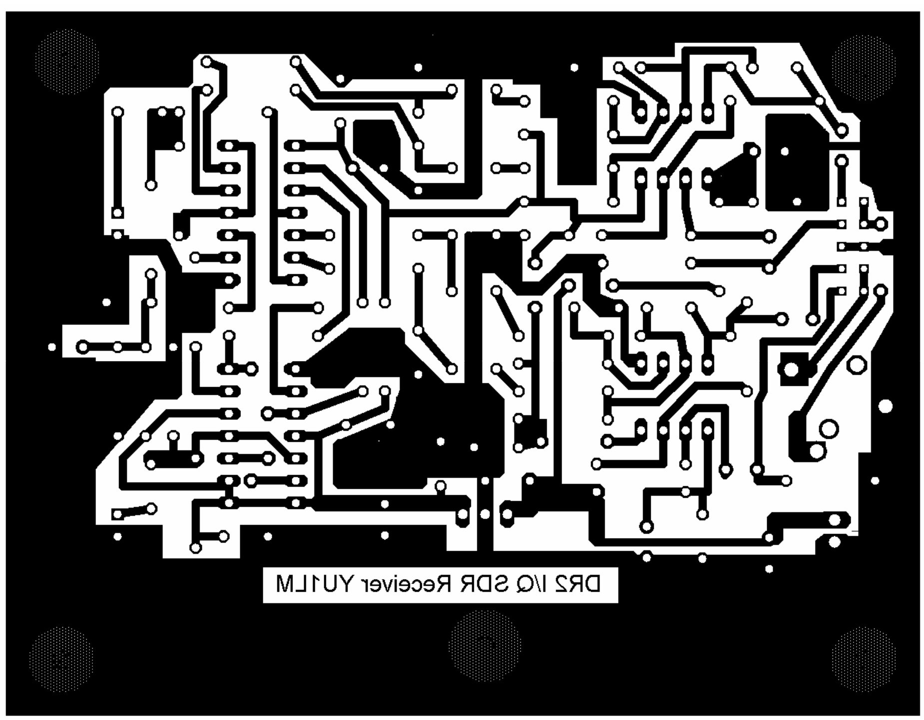
Real advantage of SDR receivers and receiving without audio IF image is possible with second SDR receiver called **DR2**. It is very simple construction but outstanding performances. Specification is similar to DR1:

6. Receiving range from 30 kHz to 35 MHz (limited with D Flip Flop 74AC74 Vcc=6V max input frequency is around 140 MHz)
7. IIP3 28-32 dBm it depends from setting and used programs (all with 16 bit sound cards). Max measured IIP3 with only 3 dB AF gain is 35 dBm but with reduced sensitivity
8. MDS 101-106 dBm
9. Sensitivity 3-6 uV for 10 dB S/N ratio, max S/N ratio I measured was 77 dB (result hard to obtain with any other only hardware HF receiver). This sensitivity is more than enough for frequencies near 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain or putting some RF preamplifier in front of DR2 to lower F (noise figure) of receiver.
10. SFDR (Spurious free dynamic range) is 88-94dB, this results are with signals spaced 2 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more. All measurements are done by use HP8662 signal generators and HP 70000 spectrum analyzer. See specification for the some very expensive HAM Rig.
11. Audio image IF rejection depend from software but without any adjustment it is between 35-45 dB and it is not changing through the HF bands. With careful adjustment in software it is possible obtain 50 or more dB.
12. DR2 receiver need external LO (local oscillator) 4 timer higher than receiving frequency.

At the first moment design of DR2 and DR1 receivers are same or very similar as it is done in Gerald AC5OG SDR1000. But I shall explain what is main difference according to main point of view is. We are talking about using the same I/Q concept. Sampling idea is the same but sampling time is 50% of pulse duration time in my design not 25% as it is in QSD based on 1 to 4 multiplexer/demultiplexer design. 50 % design enable higher frequency and better balancing. Few weeks ago I saw simulation of QSD that talking that 50% is not an optimum but my experience is quite opposite. Advantage of 50% sampling time will be described in part 2 when I shall explain transmitting part of SDR radio. The biggest disadvantage of QSD design is very bad impedance which QSD demodulator offering to band pass filters. Audio termination is good but RF very bad. Because of that I am using additional R to improve matching. Adding R will increase noise figure for 3-5 dB of receiver but I think that is for HF not important so much, atmosphere noise is much higher even at the 50 MHz. Antenna terminations is changing with frequency change but change is not so big. VSWR is better than 2. DR2 working with 100 Ohm sampling source resistance in ON for 74HC4066 is around 50-70 Ohm... Balancing using D Flip-Flop has very big advantage over all other ideas first reason is simplicity and leak of even harmonics. This is very evident in TR1 DSB modulator realization for HF output spectrum is really very clear. Switching performances as switching capacitors filer are worst than in QSD but still with very high equivalent Q.



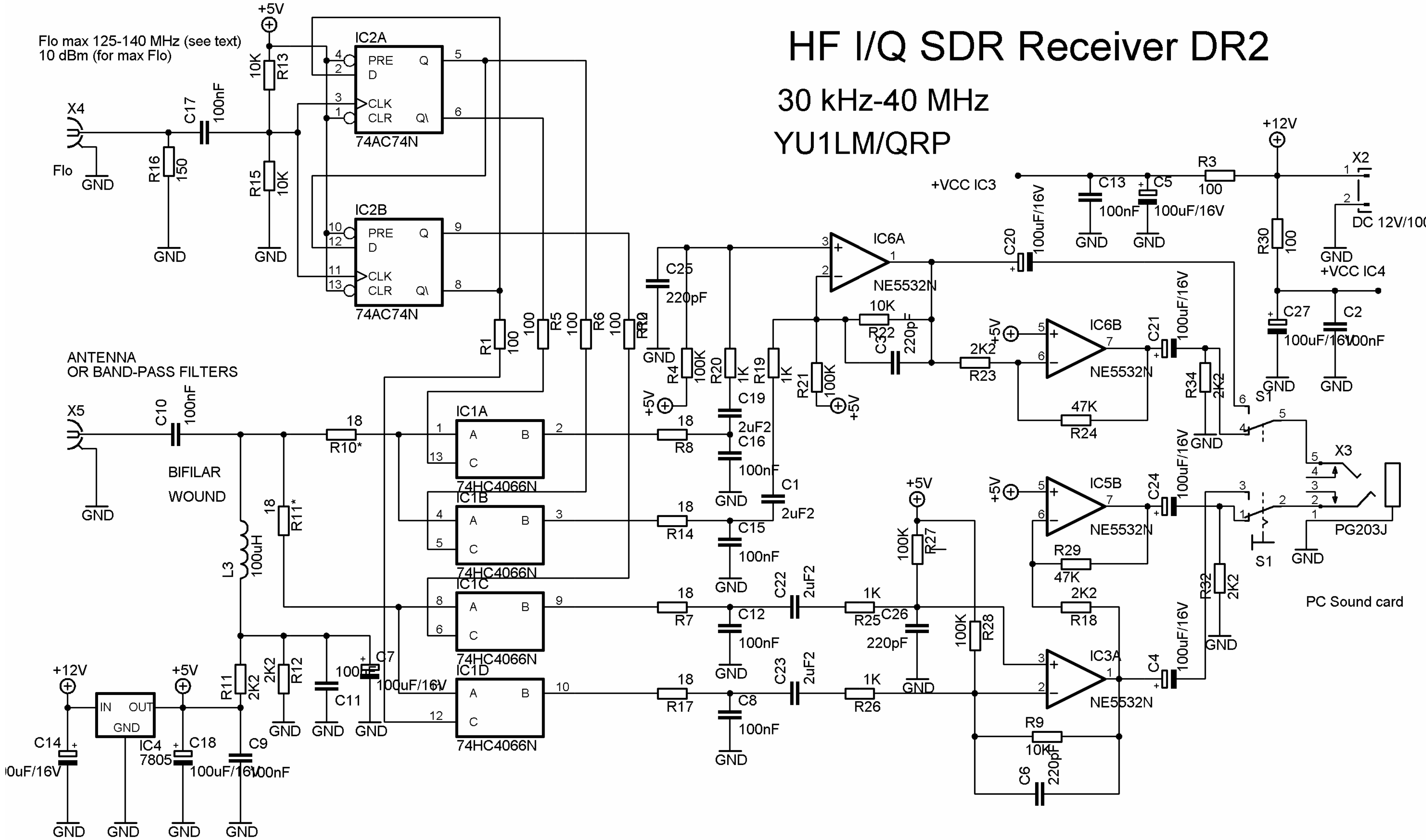
Dimensions single side PCB is 105x80 mm

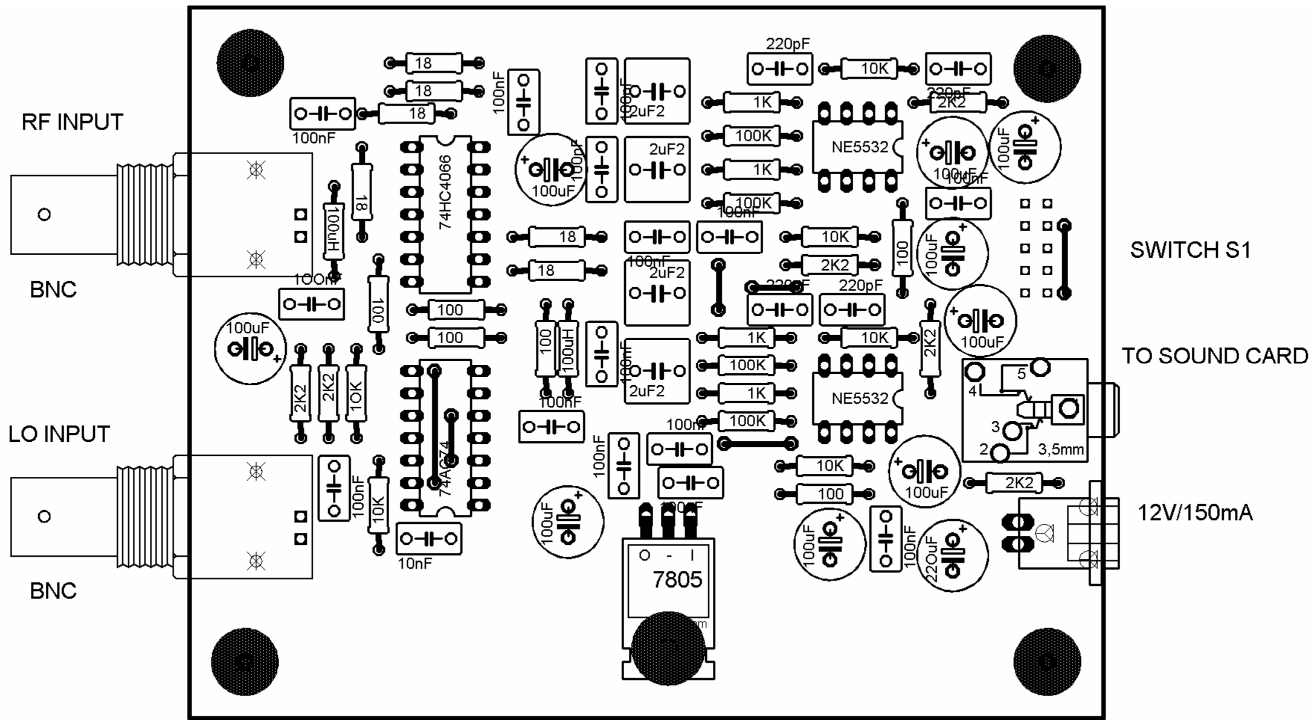


HF I/Q SDR Receiver DR2

30 kHz-40 MHz

YU1LM/QRP





This is the end of article part1, in part3 I shall keep on with improved versions of both receivers. I wish successful DR1 and DR realization and send me your comments please.

GL 73/72 Tasa YU1LM/QRP   tasa@imtel-mikrotalasi.co.yu

References:

1. *Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP*
2. *http://www.nitehawk.com/sm5bsz Leif LINARD*
3. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
4. *http://www.njqrp.org/mbrproj/9850dds.html*

www.analog.com/en/prod/0,,770_843_AD9850,00.html

http://www.qsl.net/pa3ckr/signalgenerator/

http://www.k6ese.com/DDS_Project.htm

http://ham.kiev.ua/pic/dds_ham2.html

http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

http://members.aol.com/Dl4JAL/DDS.html

http://hem.passagen.se/communication/dds.html

5. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

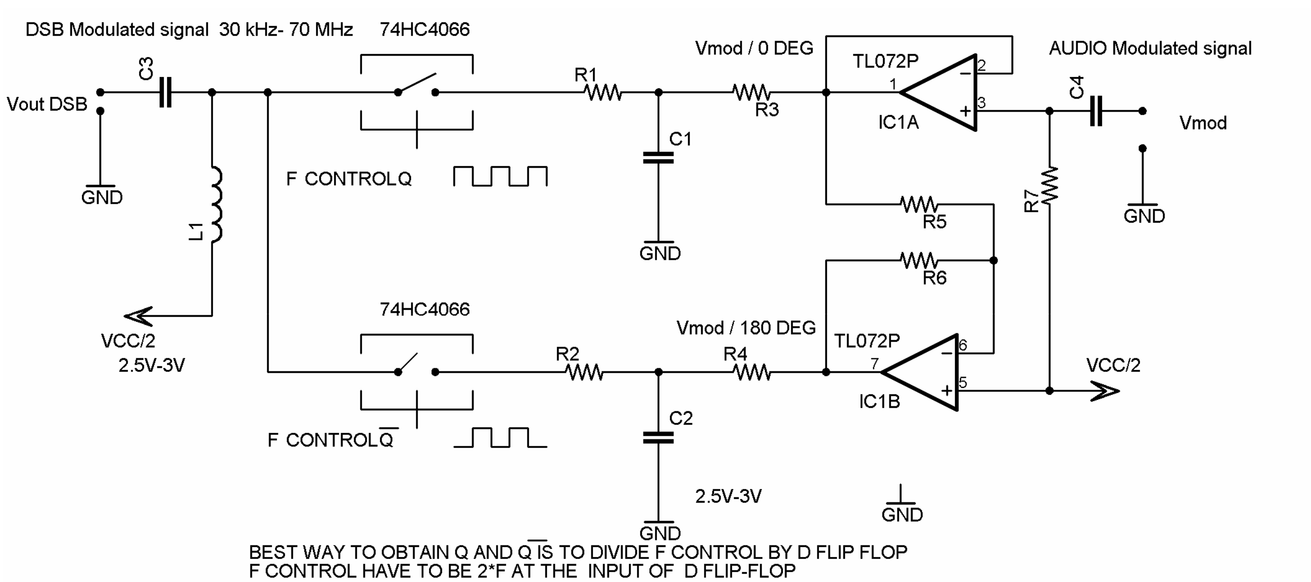
1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.95*

   *www.qsl.net/**i2phd** Alberto I2PHDhttp://gpsdo.i2phd.com/*
2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.**ciaoradio**.com*
4. *www.**g8jcf**.dyndns.org Peter G8JCF*
5. *http://www.nitehawk.com/sm5bsz Leif LINARD*
6. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
7. ***dl6iak**.ba-karlsruhe.de*

HAM Sample and Hold SDR (Software Defined Radio) Modulator/Transmitter for DSB, SSB, CW, AM, FM, DRM.. On HF (30 kHz to 70 MHz) in Connection With PC Sound Card or Other Audio Source– Make it Simple as Possible –Part 2

Dipl. Ing Tasic Sinisa-Tasa YU1LM/QRP

First I made SDR receivers DR1 and DR2 after that I tried to make transmission part of SDR radio. First attempt I made was like as it is done in original Gerald AC5OG SDR1000 article (reference 2). I made it with 74HC4052 1-4 MUX multiplexer but I was disappointed with final results as I explained in receiver's part1. Modulator worked well to maximum 10 MHz but constant degradations performances as frequency increased. During the measurements and testing SDR receivers DR1 and DR2 I connected RX inputs to the AS (spectrum analyzer). All harmonics was suppressed very much including carrier frequency. It is as I explained in first part it is great advantage in driving switches with 50/50 % duty ratio from D FF outputs. I rearranged SDR S/H sample and hold demodulator according to reference 5 by U. Rohde to transmission/modulation see below:

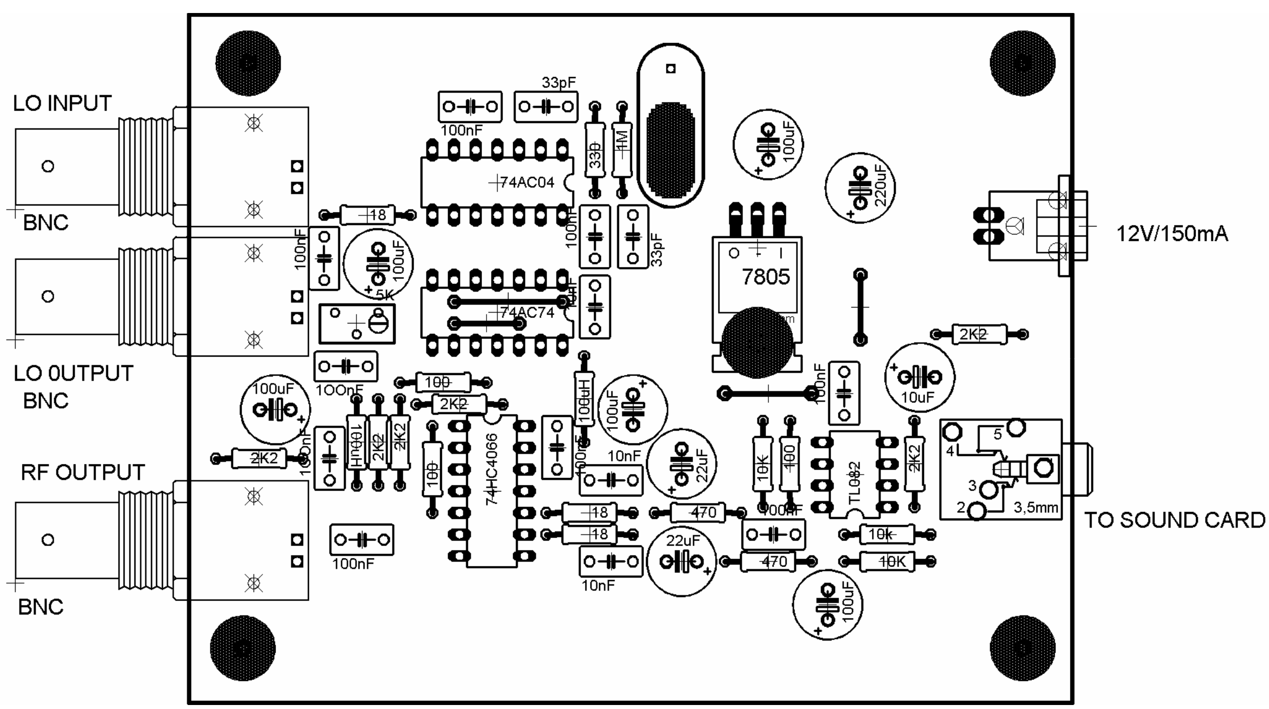


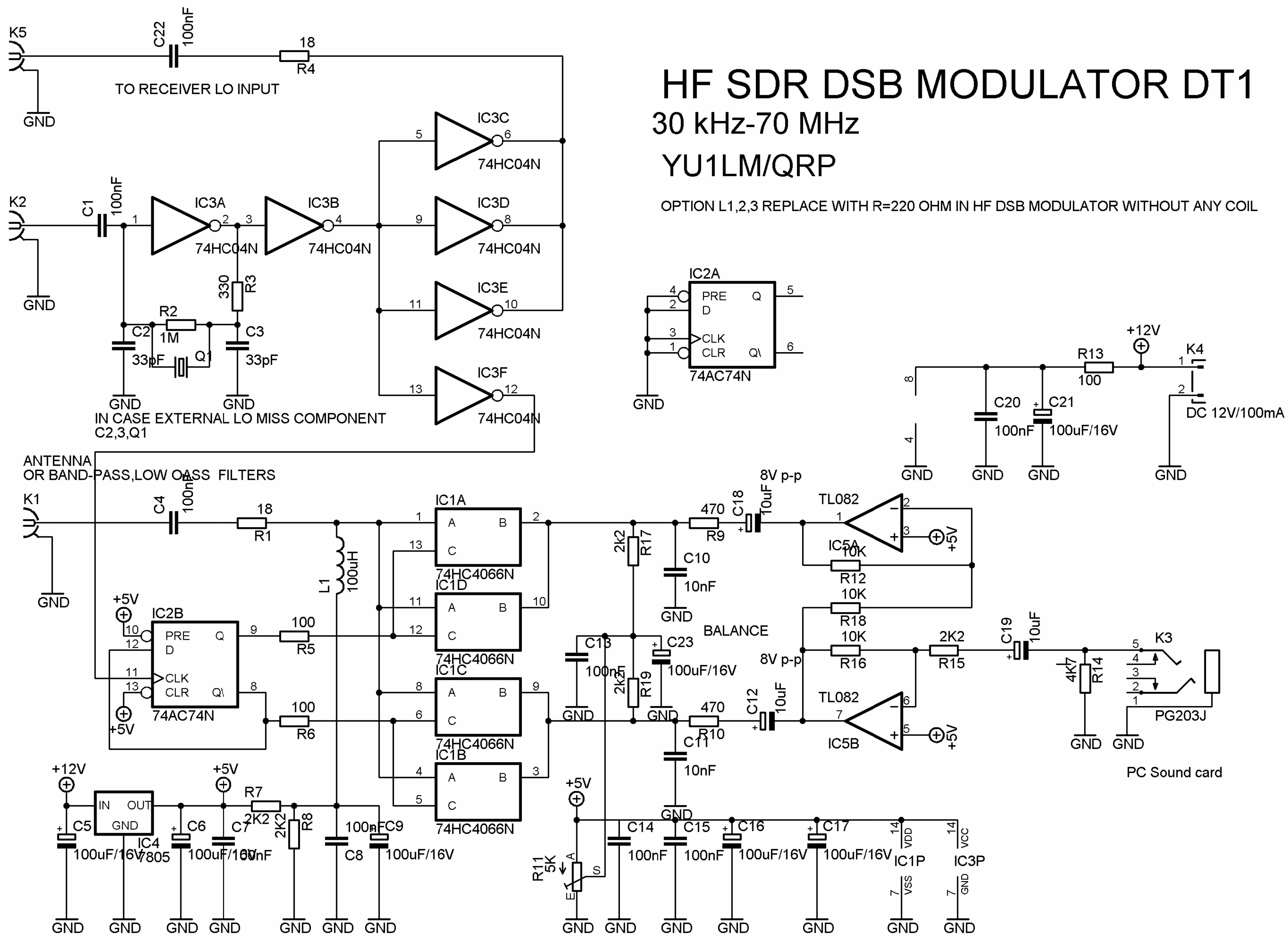
DSB MODULATOR CIRCUITS MODIFICATION BASED ON REFERENCE 5 BY YU1LM

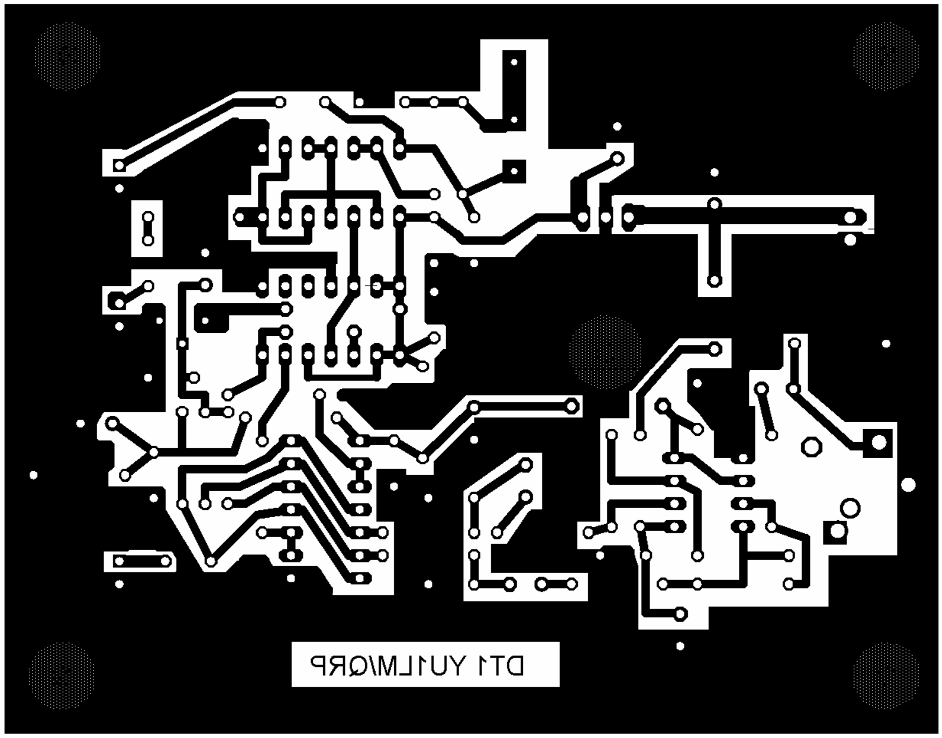
Practical measurements results from DT1 DSB modulator based on upper schematics are:

1. Frequency range from 30 kHz – 70 MHz

2. Carrier suppression without adjustment 35- 42 dB (carrier level outputs from Q and Q complement is 15-17 dBm at 50 Ohms) absolutely carrier level at output was -27 dBm. With careful adjustment with R potentiometer I achieved 55 dB and more carrier suppression and results are not changing so much through the entire frequency range 30 kHz – 70 MHz. Output spectrum is very clear harmonic frequencies are down around 45-50 dB compared to the output DSB level. Output spectrum is very easy cleaning with simple LP (low pass) filter or better with BP (band pass). See some possible solution for BP in the other articles on site or in some other references.
3. Input modulation frequency range is from near 0 Hz to about 40 kHz limited with 10nF. It is possible to increase modulation frequency and made modulator to work as double balanced mixer. I am using similar arrangement in HF front end to the 70 MHz..
4. Output level from DT1 is max to +2-+3 dBm at 50 Ohms with IMD better than -40-50 dB what’s mean that it have very good modulation linearity. This result is really very good ,or better I can say excellent. Compare these figures with other commonly used IC DSB modulators like SA612. LM1496….Vcc/2 voltage is necessary to increase linearity. Without it VCC/2 we limit upper useful frequency and we are increasing higher order IMD 5, 7, 9..That is evident in the output spectrum very much .Unwanted products are growing very quickly with increasing output level other way. There isn’t so big effect to the linearity of fundamental frequency before it arrives to the 1dB compression point.
5. DT1 adjustment is very easy. Connect AS (spectrum analyzer) or receiver and without modulated AF signal adjust with potentiometer min. That is all!!
6. Disadvantage is that we need to have twice (2 times) higher LO frequency.




HF SDR DSB MODULATOR DT1
30 kHz-70 MHz
YU1LM/QRP
OPTION L1,2,3 REPLACE WITH R=220 OHM IN HF DSB MODULATOR WITHOUT ANY COIL
TO RECEIVER LO INPUT
IN CASE EXTERNAL LO MISS COMPONENT
C2,3,Q1
ANTENNA
OR BAND-PASS,LOW OASS FILTERS
K1
K2
K3
K4
K5
C22
100nF
R4
18
C1
100nF
IC3A
IC3B
IC3C
IC3D
IC3E
IC3F
74HC04N
R2
1M
R3
330
C2
33pF
C3
33pF
Q1
IC2A
IC2B
PRE
D
CLK
CLR
Q
Q\
74AC74N
C4
100nF
R1
18
L1
100uH
IC1A
IC1B
IC1C
IC1D
74HC4066N
R5
100
R6
100
IC4
7805
IN
OUT
GND
C5
100uF/16V
C6
100uF/16V
C7
10nF
R7
2K2
R8
2K2
C8
100nF
C9
100uF/16V
R17
2k2
R19
2k2
C13
100nF
C23
100uF/16V
BALANCE
R11
5K
C10
10nF
C11
10nF
R9
470
R10
470
C18
10uF
C12
10uF
8V p-p
TL082
IC5A
IC5B
R12
10K
R18
10K
R16
10K
R15
2K2
C19
10uF
R14
4K7
PG203J
PC Sound card
R13
100
C20
100nF
C21
100uF/16V
DC 12V/100mA
C14
100nF
C15
100nF
C16
100uF/16V
C17
100uF/16V
IC1P
IC3P
VDD
VSS
VCC
+12V
+5V
GND

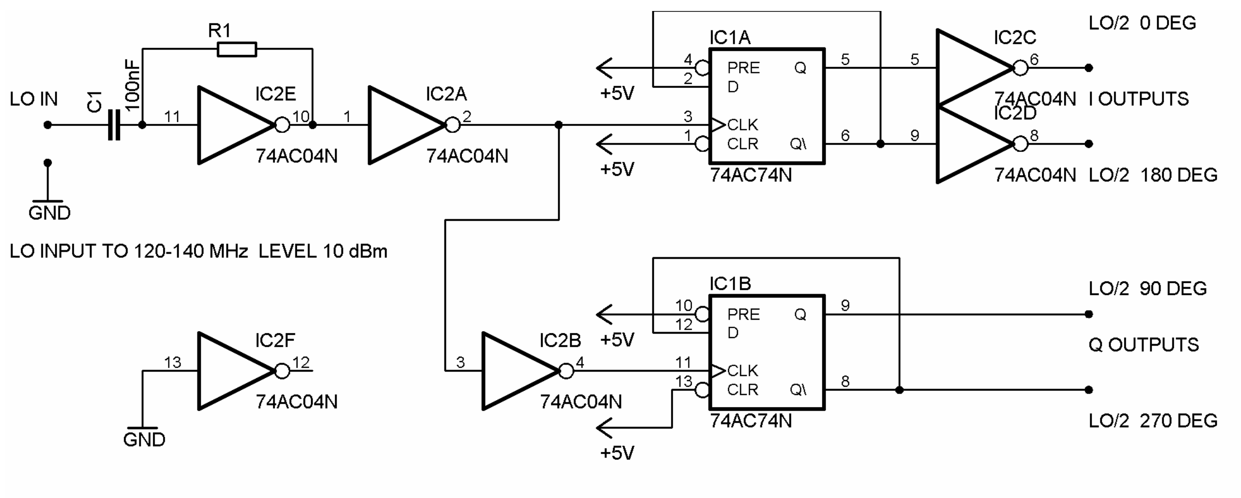


DT1 low power transmitter PCB is single side board dimension are 104 x 80 mm

DT2 is low power transmitter SSB/CW….or some other modulation which is possible make with I/Q barnches.Output level is around 0 dBm with adding simple LP or BP filters and linear amplifier it is very easy to achieve higher output levels QRP 0.5W-5W or higher with very clean output spectrum. I tried to obtain, from few HAMs who are owners of nice sophisticate RIG SDR1000 designed by Gerald AC5OG, how interface board looks like in SDR1000. My initial idea was to make hardware for SDR transceiver compatible in RT/TX command with software for SDR1000. I didn't receive any positive answer because of that I didn't realized SDR transceiver yet. I hope that it will be possible in future with new data. I had some schematics and PCBs design at papers but still not realized. Measurements results with DT2 are very similar to the DT1 except few new data:

1. Unwanted side band suppression is vicinity 30-50 dB. I used very nice program from DL6IAK, see software reference 7, for adjustment and measurements. **All measurements and results in text for SDR radio are related to the carrier suppression at 12 kHz from carrier frequency** this data is valid for both receivers and transmitters PCBs. Carrier suppression is not the same through output audio demodulated frequency band and input modulated band in modulator. It is necessary to have very good RF match between switches inside 74HC4066 (this depend from IC manufactory and frequency) and built in component in audio chain. Because of that I made improved version receivers and transmitter. New SMT components like PIV…FST...CBT with lower Rds-ON enable better match because of that their influence to the unbalance, with adequate design, is small.

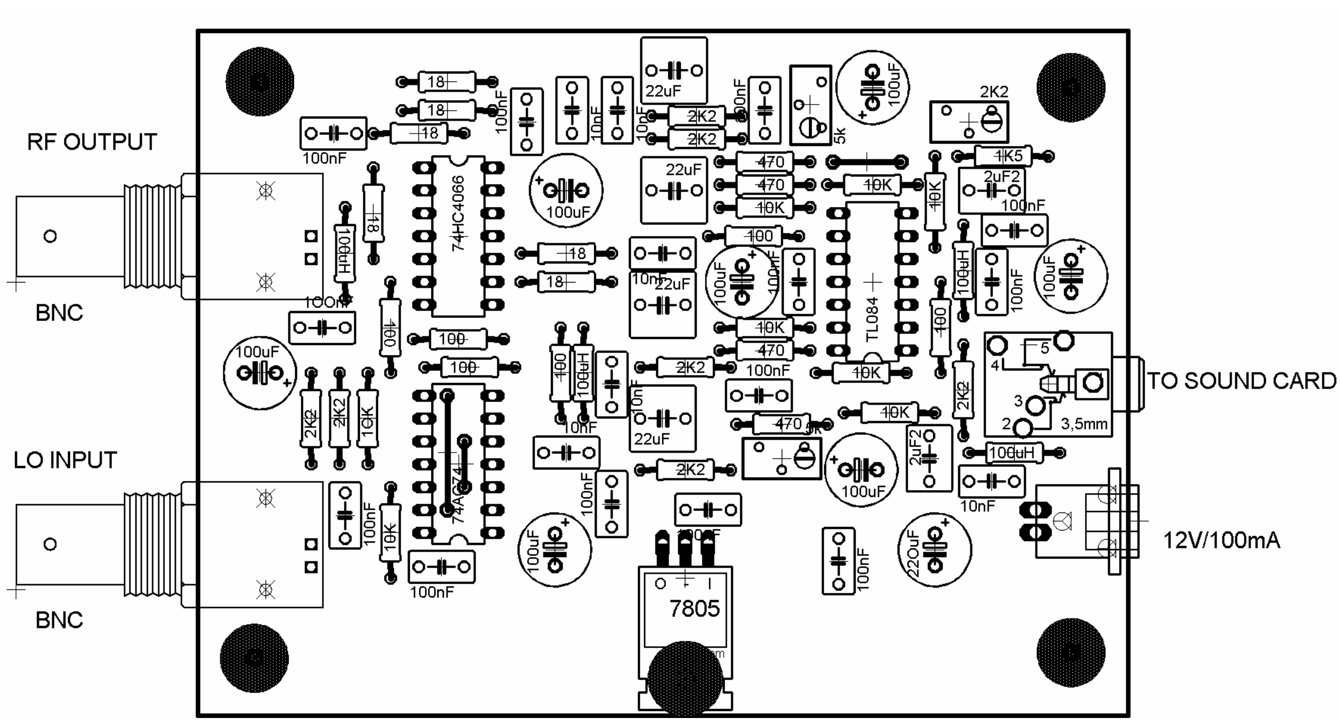
2. Frequency range is from very low 30 KHz to the 30-35 MHz and it is limited with built in components. I have schematics below which enable that we can use only twice (2) higher frequency for LO .If LO input frequency is higher than 10 MHz it is necessary to make compensation phase between D FF outputs. At input frequency 60 MHz differences between I Q outputs are around 2-6 DEG Delay in invertors is 3-5 nsec and also it is important IC slew rate at different frequencies this mean that is not possible easy hardware compensate delay. The phase compensation depend mainly from used 74HC4066 components and PCB layout also this difference or error is very easy compensating in the most softwares but not in the all. Results are not changing in same HAM bands and difference has fixed amount.

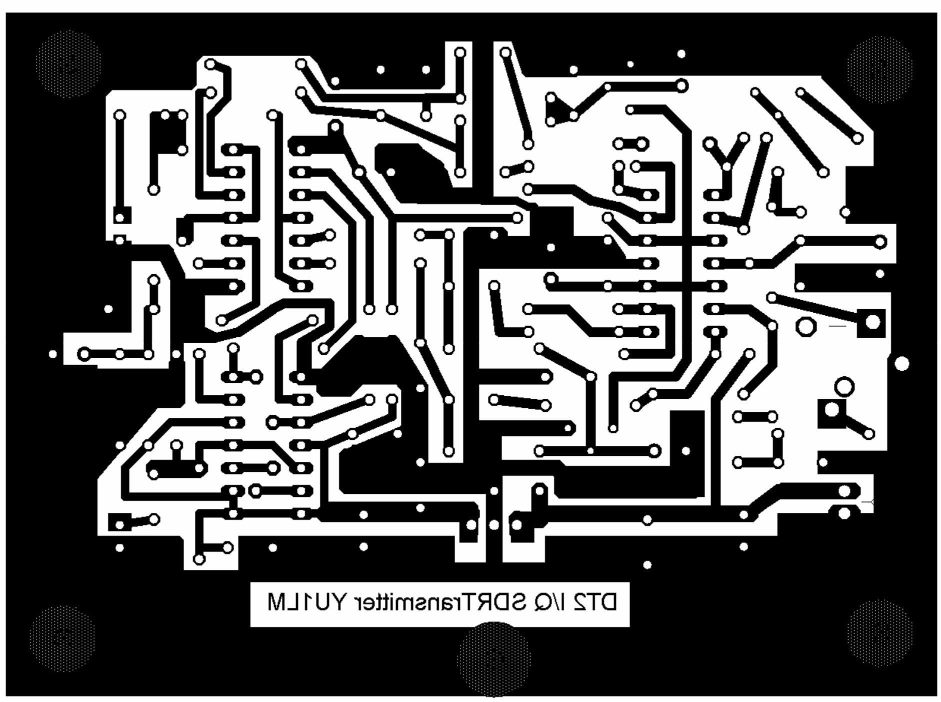


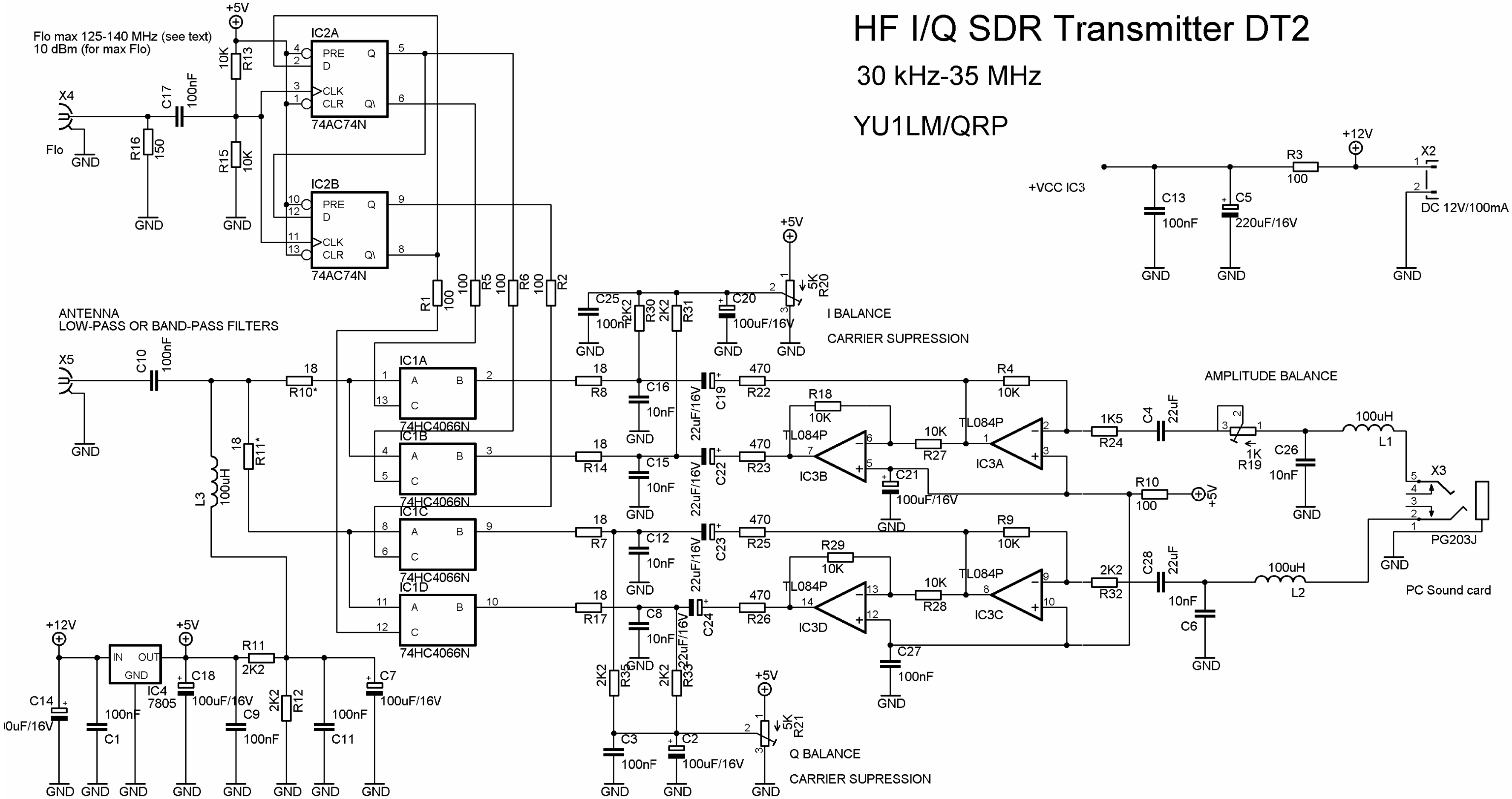
ALTERNATIVE WAY TO OBTAIN I AND Q BRANCHES FOR SDR TRANSMITTER by YU1LM/QRP

3. DT2 adjustment is very easy and it has a 2 steps. First step: connect AS (spectrum analyzer) or receiver and without modulated AF signal adjust with one 5K potentiometer in I branch min and the same procedure with second 5K potentiometer in Q. This procedure is iterative process and it has to be repeat few times to obtain min. After that connect audio modulation signal 12 kHz (best program is from DL6IAK) I and Q branches and with 2K2 potentiometer adjust about 6 Vp-p at the output of OPAMP and max rejection opposite side band at AS or receiver. Optimum frequency for adjustment is close to the end of working frequency for HF it is 26- 27 MHz. That is all!!
4. Disadvantage DT2 is 4 times higher LO frequency and balancing is not the same through the entire input audio bandwidth (20 Hz- 20 kHz)

DT2 is one side PCB and dimensions are 75 x 105 mm






HF I/Q SDR Transmitter DT2
30 kHz-35 MHz
YU1LM/QRP
Flo max 125-140 MHz (see text)
10 dBm (for max Flo)
X4
Flo
ANTENNA
LOW-PASS OR BAND-PASS FILTERS
X5
IC2A
IC2B
74AC74N
IC1A
IC1B
IC1C
IC1D
74HC4066N
TL084P
IC3A
IC3B
IC3C
IC3D
IC4
7805
I BALANCE
CARRIER SUPRESSION
Q BALANCE
CARRIER SUPRESSION
AMPLITUDE BALANCE
+VCC IC3
X2
DC 12V/100mA
X3
PG203J
PC Sound card
GND
+5V
+12V

I shall keep on with improved versions of SDR receivers DR1 and DR2 and transmitter DT2 in part 3 as my proposal for homebrew builders. I wish you successful DT1 and DT2 realization and send me your comments please.

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References:

1. *Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP*
2. *http://www.nitehawk.com/sm5bsz Leif LINARD*
3. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
4. *http://www.njqrp.org/mbrproj/9850dds.html*

www.analog.com/en/prod/0,,770_843_AD9850,00.html

http://www.qsl.net/pa3ckr/signalgenerator/

http://www.k6ese.com/DDS_Project.htm

http://ham.kiev.ua/pic/dds_ham2.html

http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

http://members.aol.com/Dl4JAL/DDS.html

http://hem.passagen.se/communication/dds.html

5. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

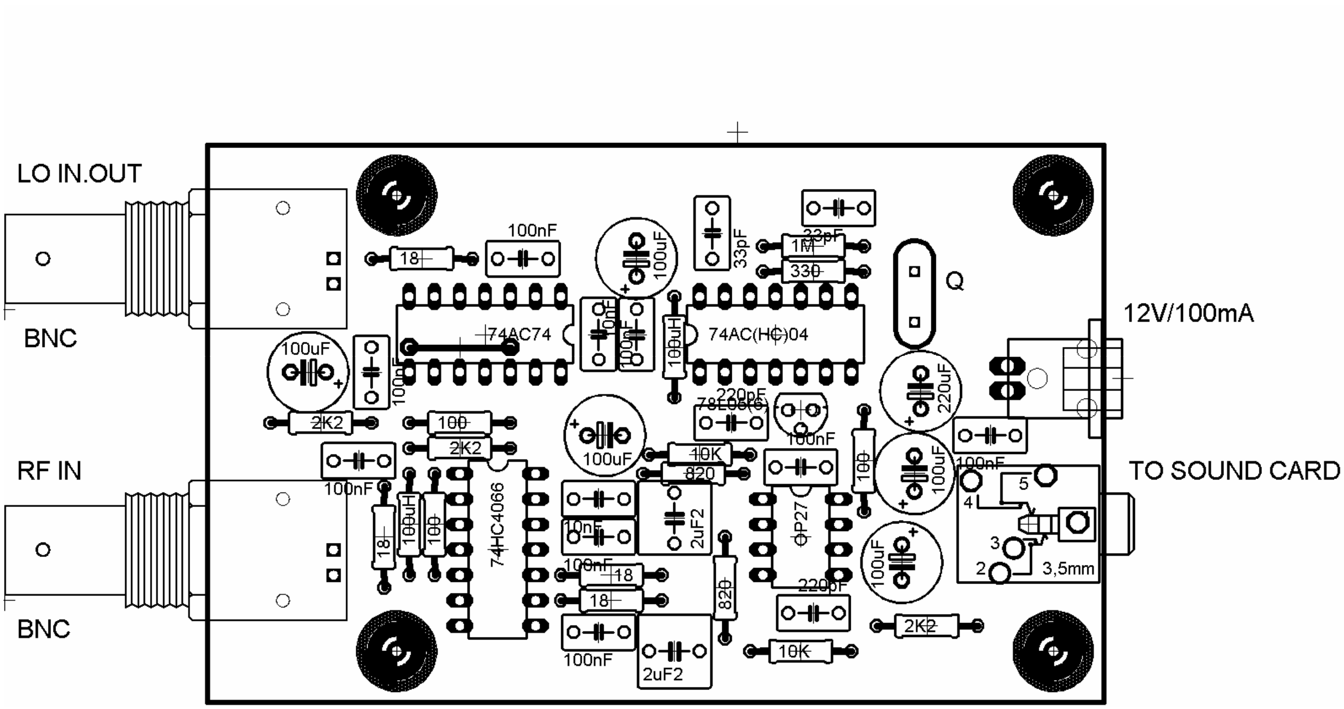
1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.95*

   *www.qsl.net/**i2phd** Alberto I2PHDhttp://gpsdo.i2phd.com/*
2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.**ciaoradio**.com*
4. *www.**g8jcf**.dyndns.org Peter G8JCF*
5. *http://www.nitehawk.com/sm5bsz Leif LINARD*
6. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
7. ***dl6iak**.ba-karlsruhe.de*

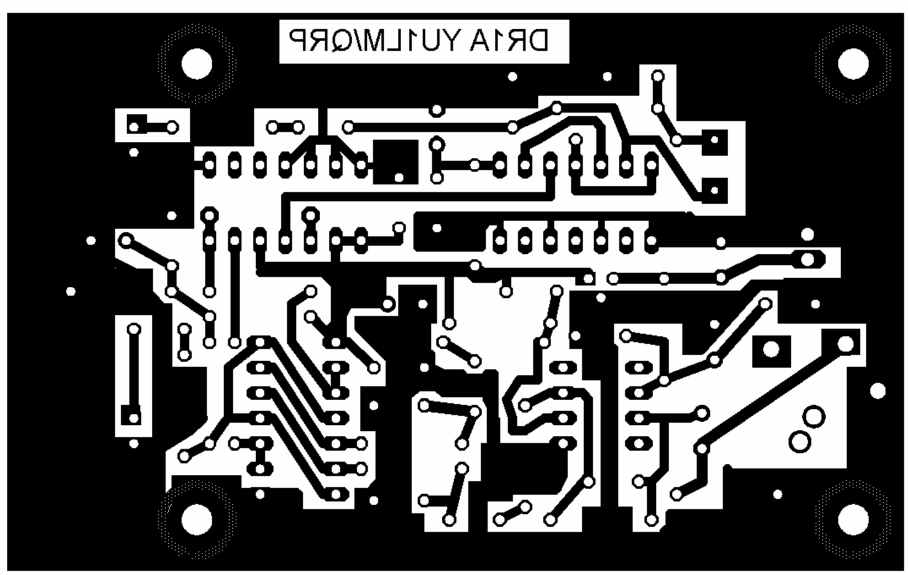
FINAL SOLUTION – Optimized HAM Sample and Hold SDR (Software Defined Radio) Receivers, Modulator/Transmitter for DSB, SSB, CW, AM, FM, DRM…. HF (30 kHz to 70 MHz) in Connection With PC Sound Card Make it Simple as Possible with Outstanding Performances–Part 3

Dipl. Ing Tasic Sinisa-Tasa YU1LM/QRP

In this article I shall describe final realization for both SDR radio receivers and transmitter. DR1A , DR2A and DT2A are with improved performances compared to the basic models with little more components. I started with some explanation in part 2. Switches have a finite resistance not 0 Ohms typical value for one 74HC4066 switch is 50 Ohms but this value depends from working frequency. This value for resistance is not problem in I/Q systems it is very important that we have a very good amplitude balance between branches. ON resistance in switches are not the same in all switches in one IC 74HC4066 and this parameter is frequency very depended also. This amplitude unbalances between switches lead to the very poor or not well predicted unwanted side band rejection. We need to have very similar audio AF branches which lead to the very well matched RC components through entire demodulated /modulated audio band. This demand is not like in classic I/Q DC (direct conversion) receivers but if we have a better match results will be better for the sure. Some unbalances are possible compensate in software but not in all programs. I started my SDR experiments with MIL 74HC4066-s on ceramic which have extremely good match between switches in one IC. All measured results are done with this IC-s 12 kHz from the carrier frequency. After that I ordered twice few new IC-s and results was not as good as previously. The results were not so good unwanted side band rejection fluctuated very much from one IC to another. I measured results between 15 dB to the 45 dB unwanted side band rejection. It depended from samples, frequency and receiver/transmitter type. Other RX/TX specifications aren't changing very much compared to the first realisation.For example IIP3 was still very good. I decided to improve SDR performances; one way was to use some newer one modern ICs FST.. PIV…CBT… which have very small switch Rds ON, few Ohms. Small ON resistance manufactory ICs achieved with new modern technology. Typically values for ON resistance are around 2-3 Ohms with adequate design switches unbalance have to be neglected. I choose hard way to keep on with IC -s 74HC4066. In article to the end I shall keep on with my FINAL solution for the SDR Radio both receivers /transmitters based on IC 74HC4066. Final solutions from my side are DR1A,DR2A and DT2A and my proposal for the builders. Results are similar to the measured previously (with extremely well match switches inside one IC) now with different ICs from different manufactories fluctuation is small. A benefit is 1-2 dB improvement in dynamic range this results is very sensitive to the measurements conditions and software program setup. I shall give also new PCB for DR2 which enable compensation amplitude unbalance between I/Q .



HF SDR receiver DR1A, single side PCB dimensions are 90 x 55mm



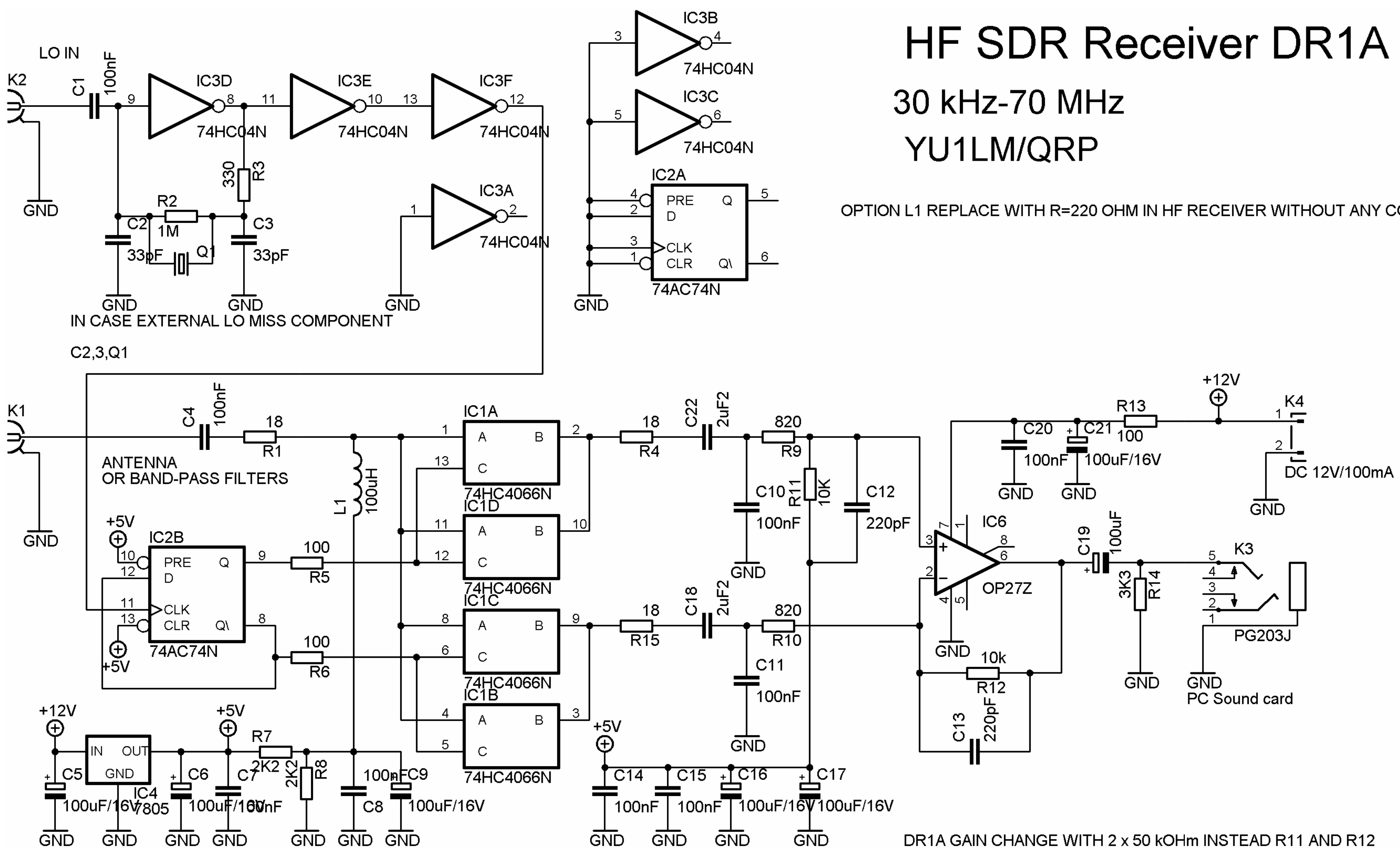
It is possible changing AF gain continuously in DR1A with tandem (double) potentiometer 2 x 50 kOhm instead twice (2) fixed 10k in feedback OP AMP OP27. This solution will improve receiver sensitivity at higher frequencies >10 MHz reducing NF OP AMP (higher amplification give lower NF noise figure) see very illustrative article from Dan N7VE in RF Design and reprint on Alberto I2PHD site..

HF SDR Receiver DR1A

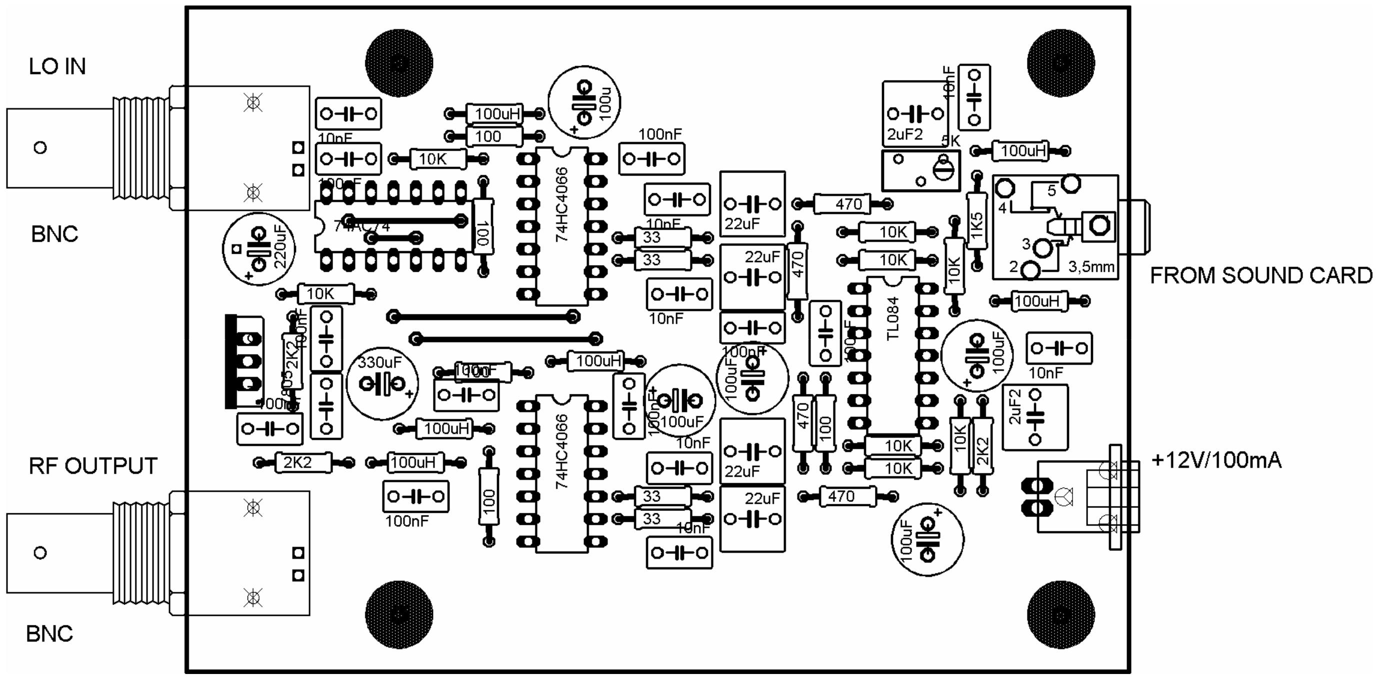
30 kHz-70 MHz

YU1LM/QRP

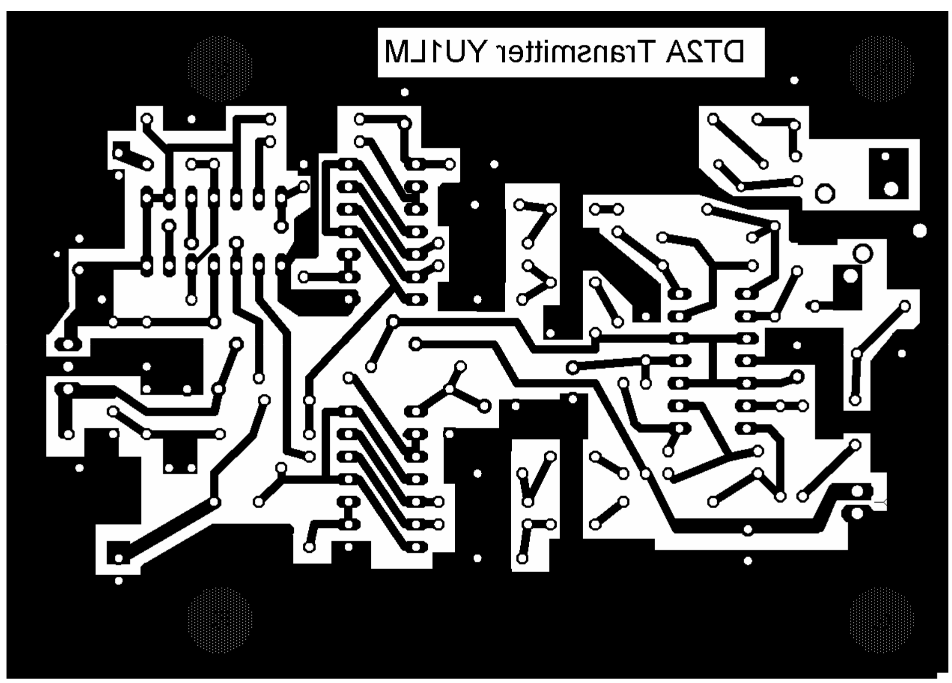
OPTION L1 REPLACE WITH R=220 OHM IN HF RECEIVER WITHOUT ANY COIL

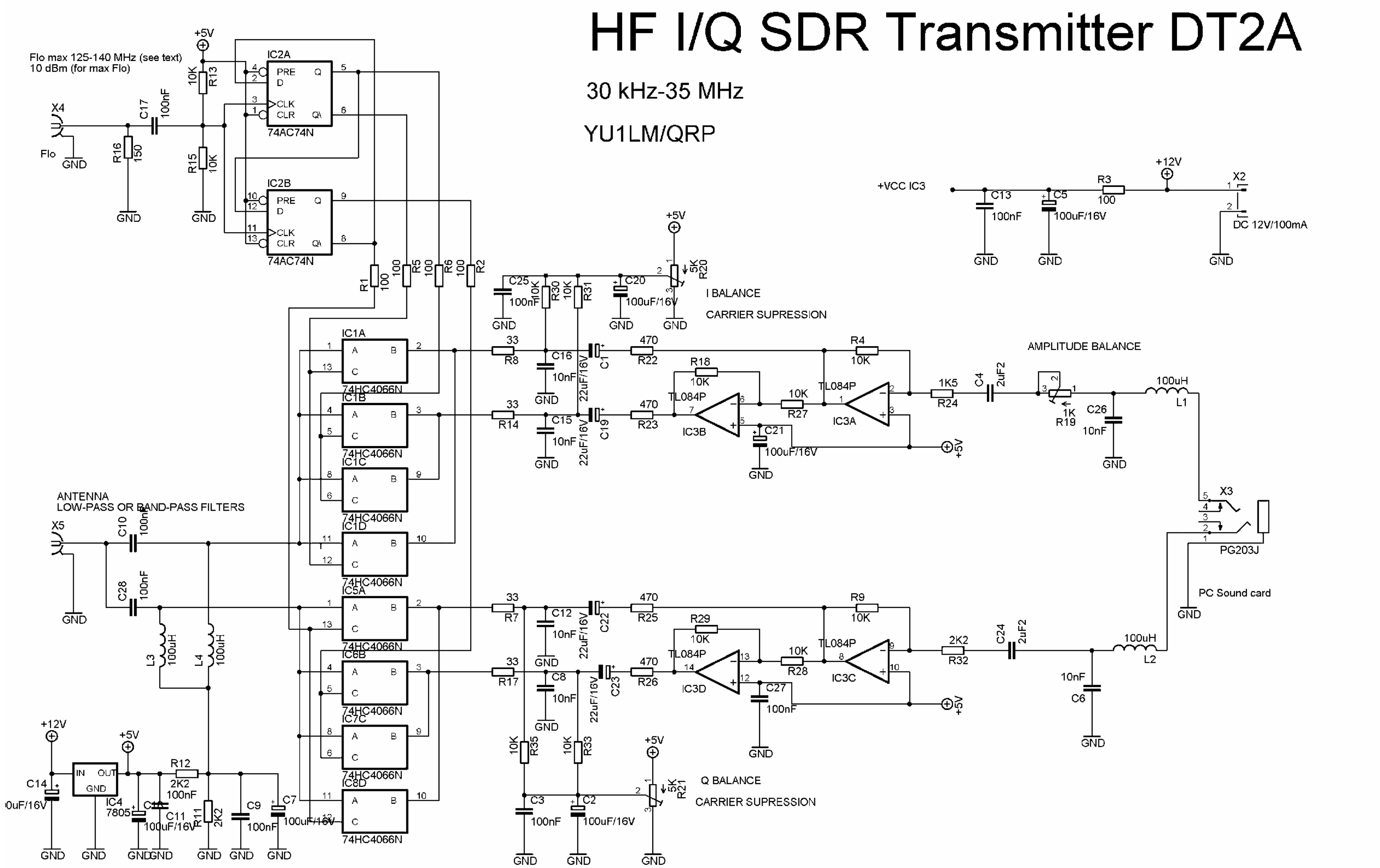


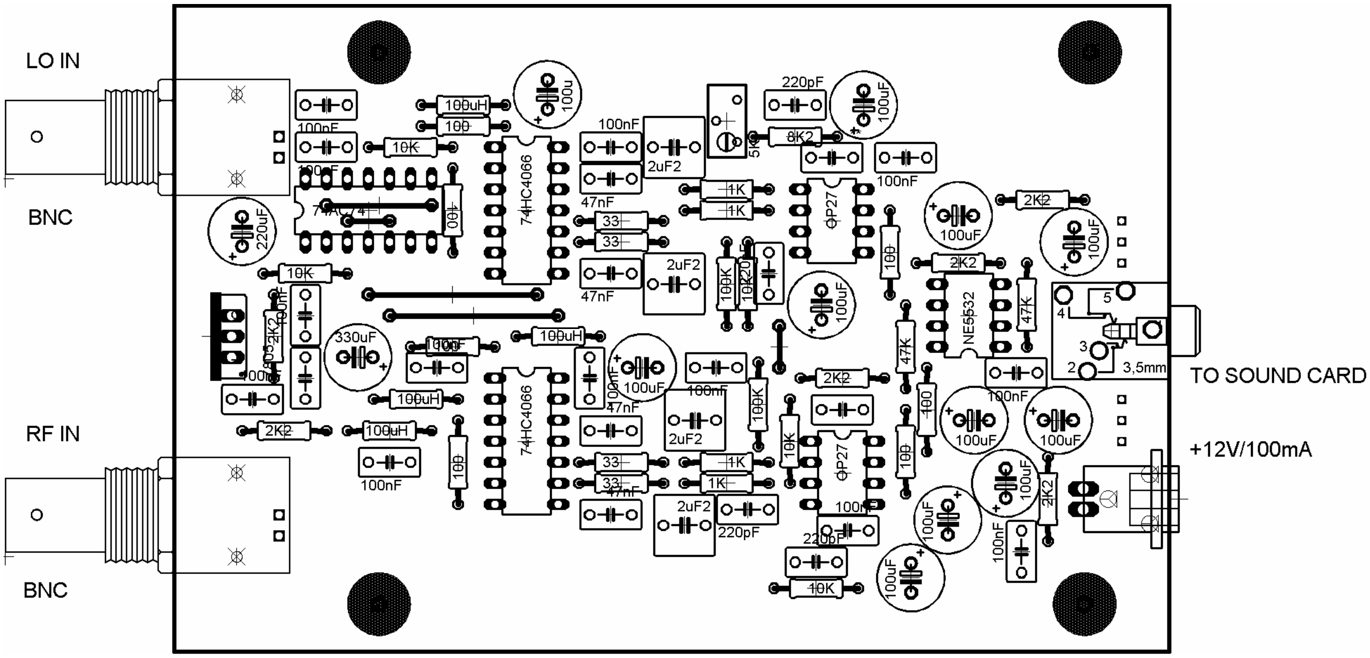
DR1A GAIN CHANGE WITH 2 x 50 kOHm INSTEAD R11 AND R12



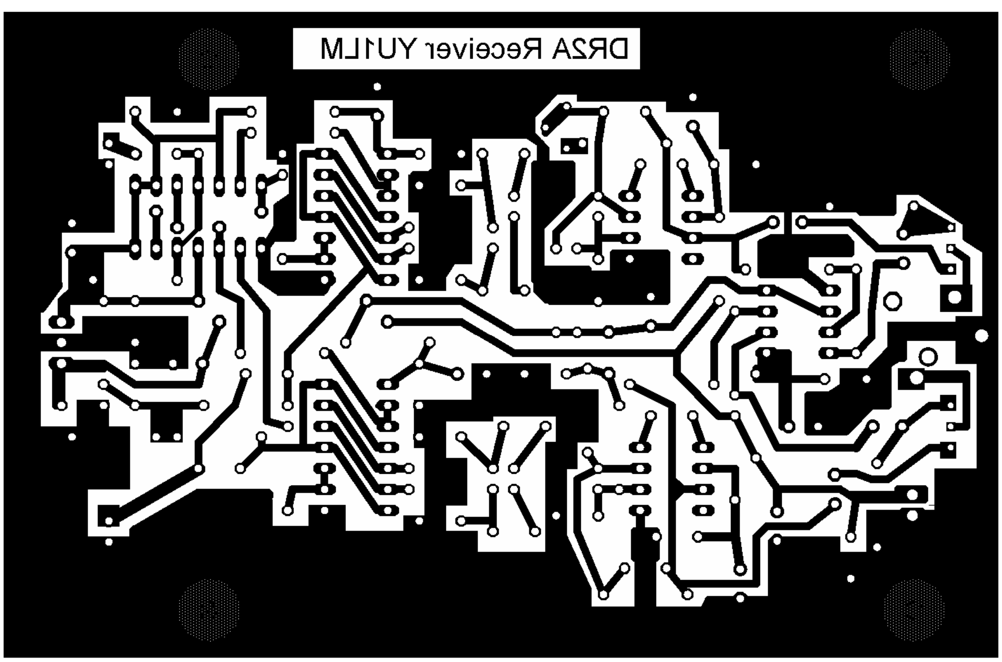
Low power HF transmitter DT2A, single side PCB dimensions are 107 x 75 mm

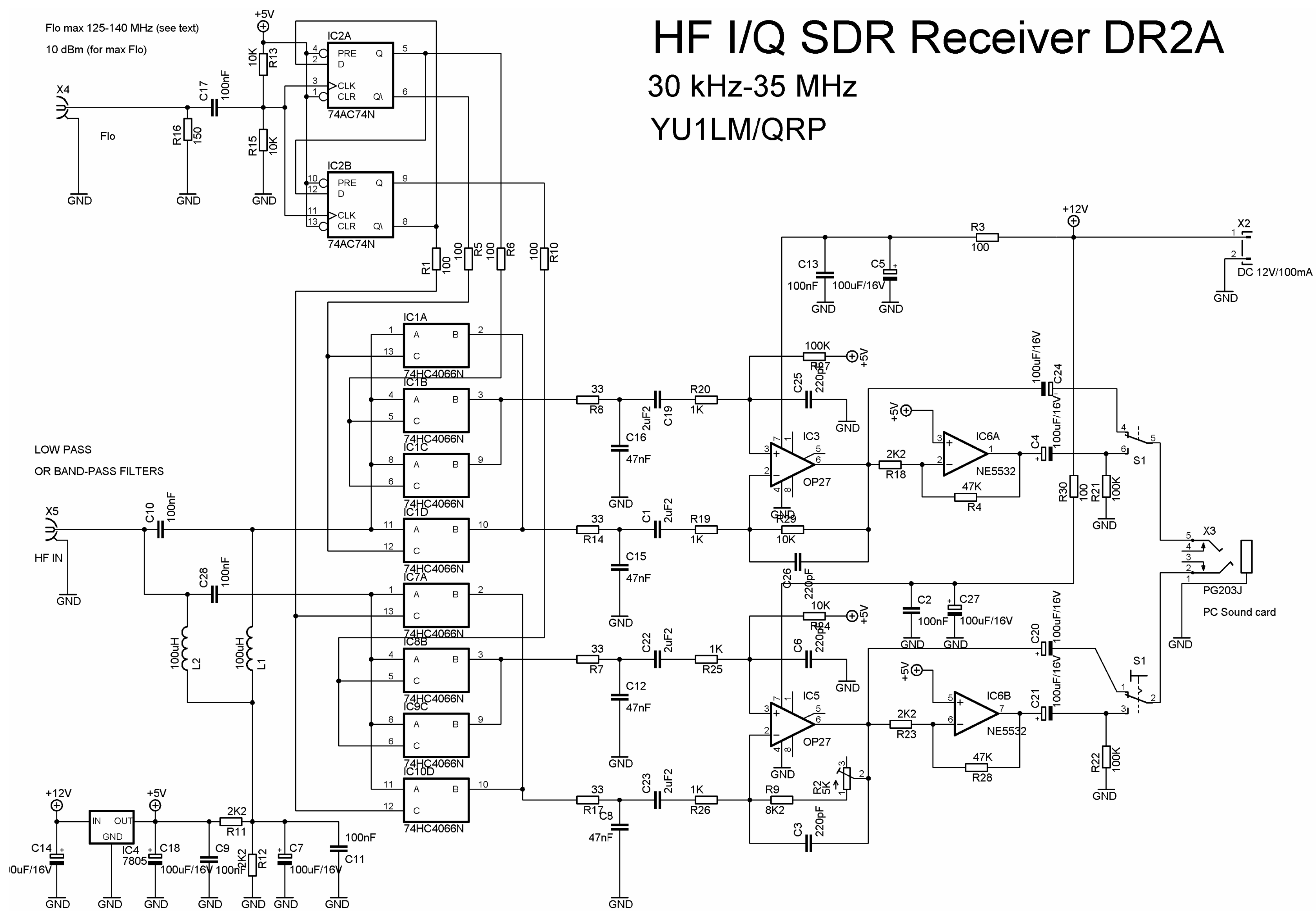


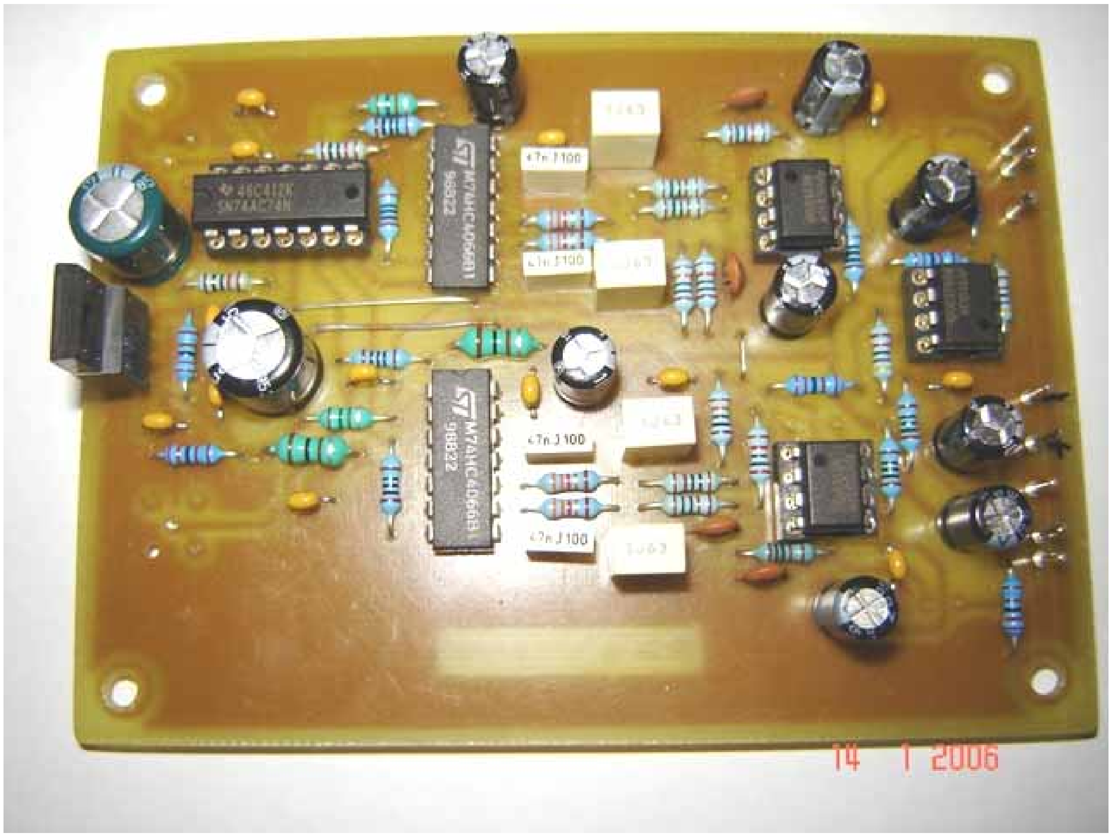

HF I/Q SDR Transmitter DT2A
30 kHz-35 MHz
YU1LM/QRP
Flo max 125-140 MHz (see text)
10 dBm (for max Flo)
ANTENNA
LOW-PASS OR BAND-PASS FILTERS
I BALANCE
CARRIER SUPRESSION
Q BALANCE
CARRIER SUPRESSION
AMPLITUDE BALANCE
+VCC IC3
DC 12V/100mA
PC Sound card
PG203J
74AC74N
74HC4066N
TL084P
7805



HF SDR receiver DR2A, single side PCB dimensions are 78 x 120 mm

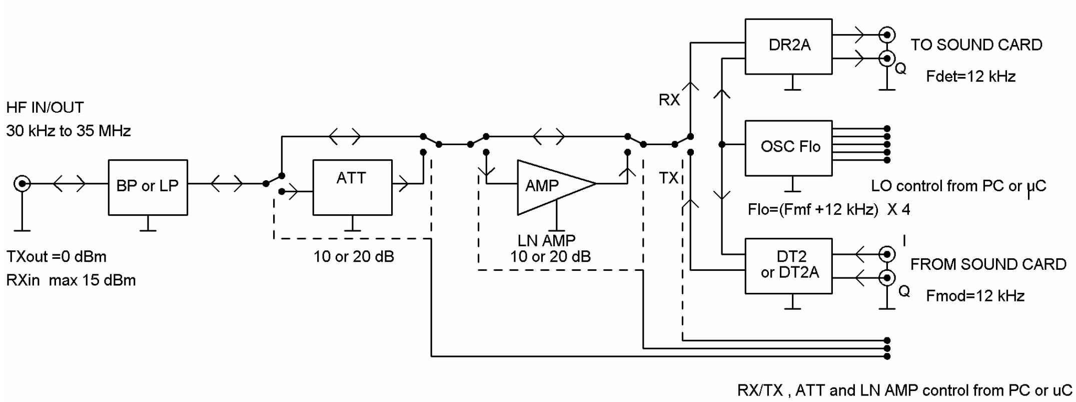



HF I/Q SDR Receiver DR2A
30 kHz-35 MHz
YU1LM/QRP
Flo max 125-140 MHz (see text)
10 dBm (for max Flo)
Flo
LOW PASS
OR BAND-PASS FILTERS
HF IN
74AC74N
74HC4066N
OP27
NE5532
7805
DC 12V/100mA
PG203J
PC Sound card

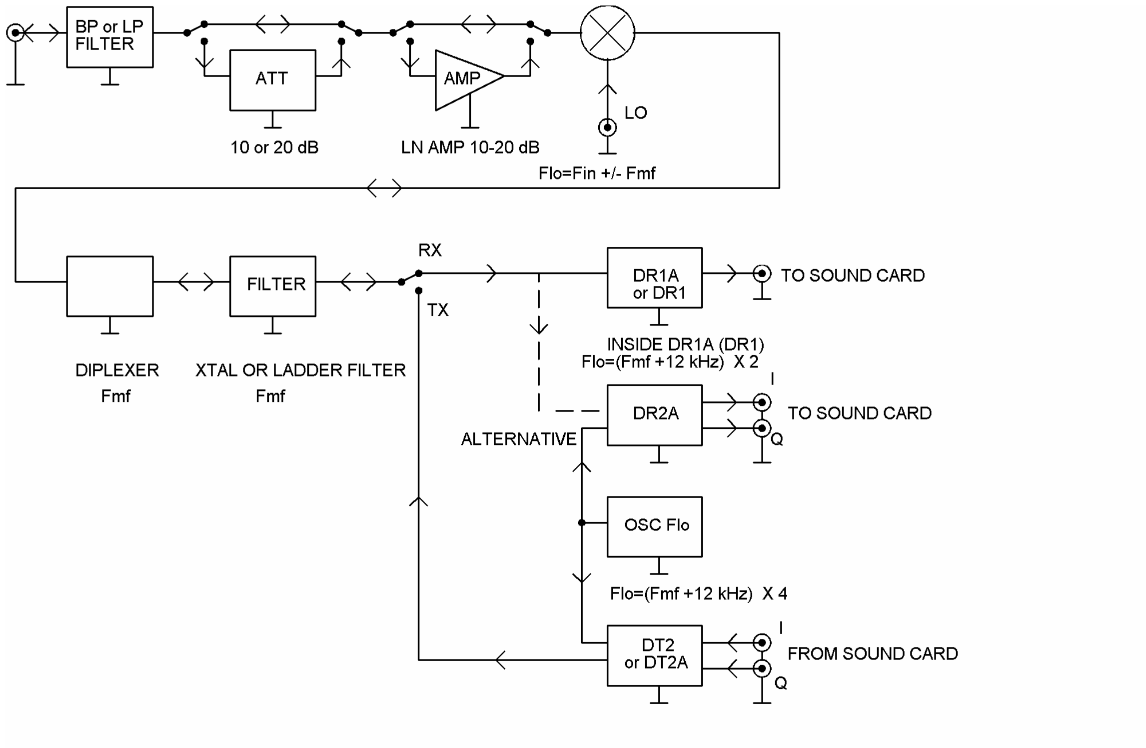


HF SDR receiver DR2A built by Batke YU1OL

Practical use SDR receivers and transmitters



USE SDR RECEIVERS AND TRANSMITTERS BY YU1LM INSIDE THE HF TRANSCEIVERS



USE SDR RECEIVERS AND TRANSMITTERS BY YU1LM INSIDE THE HF SUPER HET. TRANSCEIVERS

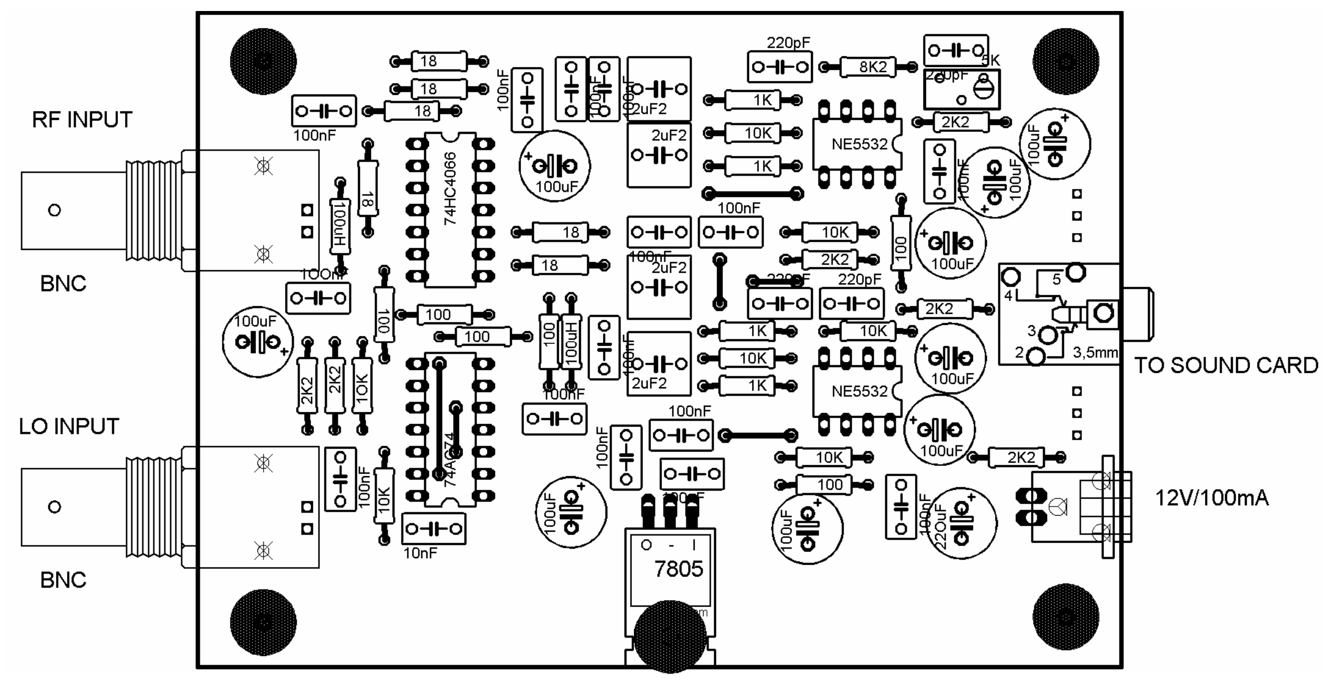
How to use SDR receivers and transmitters inside HF transceivers is question for the homebrew builders see my proposal figs up. One way is to make transceiver like Gerald AC5OG SDR1000 was do. I am waiting with big expectation new SDR software which will Aberto I2PHD release in the soon future for transmission. SDR receiver software done by Alberto I2PHD is my favorite software for SDR radio receiving and all measurements which I made ware done by this software. This realization is complicated dictated by LO realization and control interfaces. Simplest way is to use it as had been proposed by similar designs done by HAM OMs Oleg UR3IQO in T03DSP, Peter G3XJP in Picastar and W7PUA.in DSP10. In this moment I tried only second version. Results are very good but I have to do some improvement to make competent transceiver for my main task good contest transceiver. Now in this moment I can transmit only CW. I shall publish some new modules which I tested and I think that it will be interesting for homebrew builders.

My idea was from the beginning not to made big theoretical discussion about SDR radio, this is excellent done in references below, but to intrigued potentional homebrew to try new technique and to see how easy is to open some new frontiers in HF radios and homebrew. I apologize for mistakes which I made also I apologize for my English it is not my native language. If you have some comments positive or negative don’t hesitate write to me I wish you successful building my SDR modules.

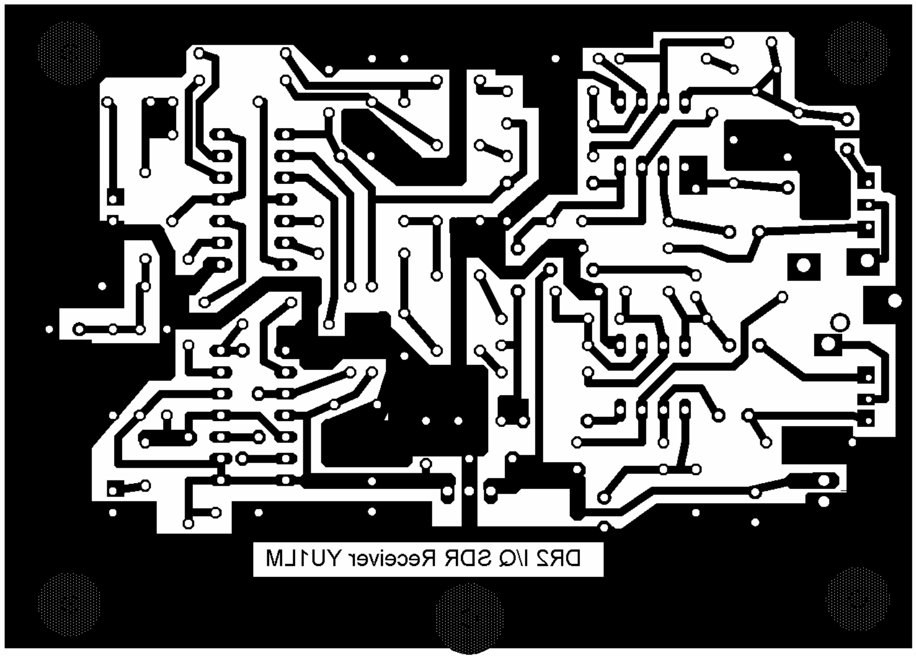
VY 73/72 Tasa YU1LM/QRP tasa@imtel-mikrotalasi.co.yu

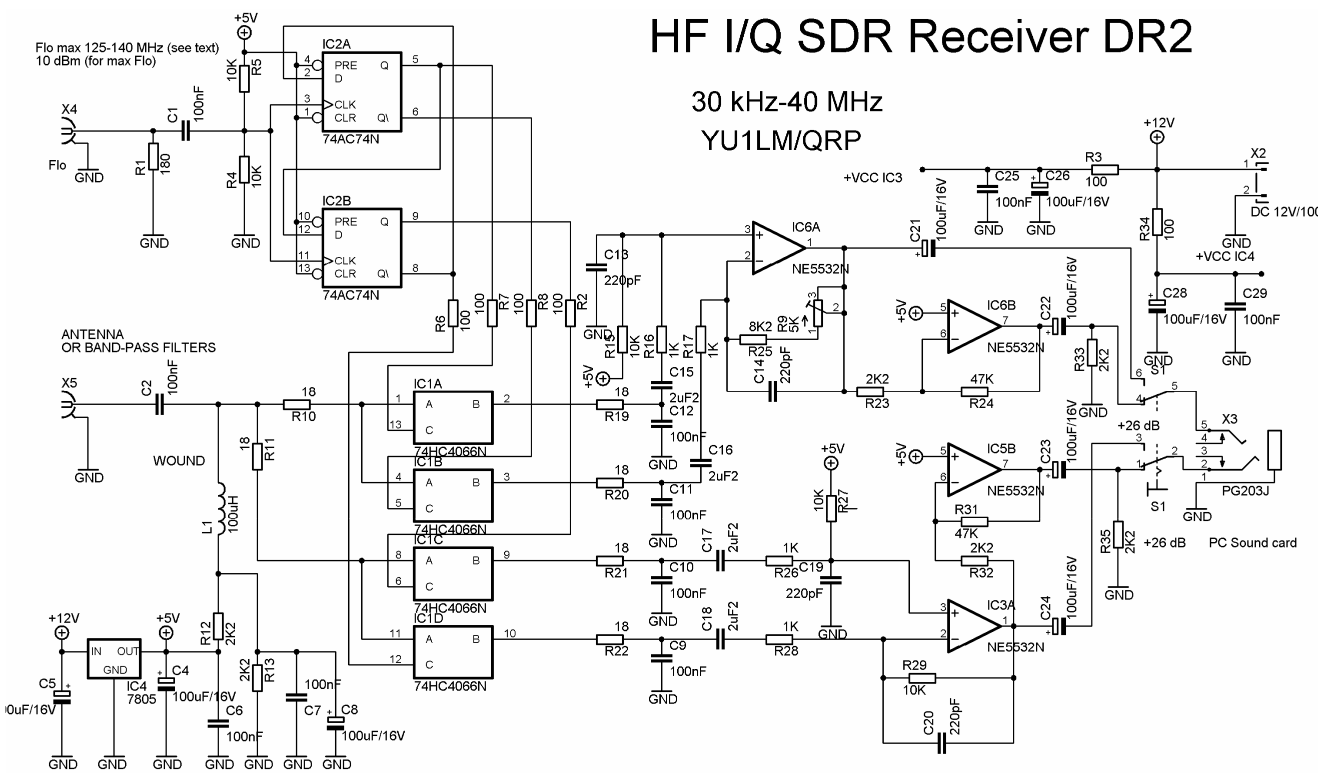
PRACTICE

1. Some OMs wrote me and other told me that OP AMP series LM741 .LM358 and LM324 not working good inside SDR receivers and transmitters .They have very big distortions for higher output levels. I didn't found reason why these happenings I still think that is working condition correct .When I tried this ICs problem exist. At the beginning I didn't try this OP AMP because they are very noisy. Reason why this irregular work happening is still mystery for me? OP AMP which I tested and they are working correct (they are giving 8 Vp-p at the output before they are starting clipping Vcc=5V) are OP07,OP27,OP275 ,TL071,TL072 ,TL084,LF356,CA4140,NE5532 and NE5534.
2. In DR2 I permutated pins which isn't problem for work but it isn't good correspondence between schematics and PCB, thank you Mike N2EAB. Also I read wrong value for some resistors (6 colors) incorrect values degrade CMRR of OP AMP. Because of that and some new test which reduces noise I changed PCB, thank you Batke YU1OL. I made new PCB and corrected schematics see below!!



HF SDR receiver DR2, single side PCB dimensions are 75 x 107 mm





3. IC 74HC4066 is not possible substitute with other 4066 IC s in text I explain problem is frequency and IL limitation (much higher ON resistance with frequency) HEF4066 useful to 7 MHz. 74AC74, 74AC02 and 74AC04 is possible change with 74HC74,

74HC02 and 74HC04 to LO input frequency 50 MHz. CD4066 is possible use to 1.5-2 MHz. LS IC is not compatible with CMOS IC levels and behavior is un predictable.

References:

1. *Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP*
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http://hem.passagen.se/communication/dds.html

5. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

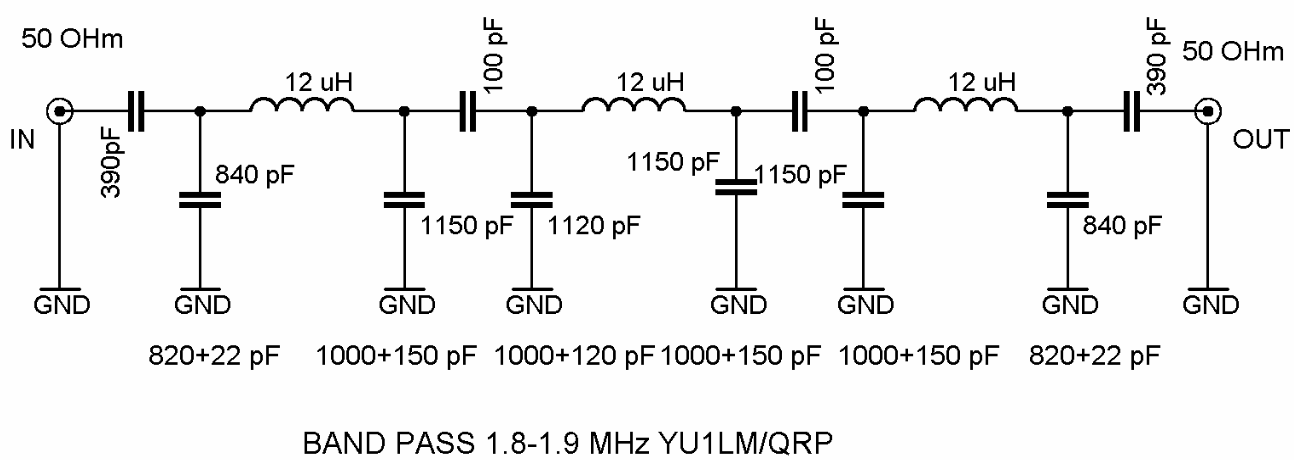
1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.95*

   *www.qsl.net/**i2phd** Alberto I2PHDhttp://gpsdo.i2phd.com/*

2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.**ciaoradio**.com*
4. *www.**g8jcf**.dyndns.org Peter G8JCF*
5. *http://www.nitehawk.com/sm5bsz Leif LINARD*
6. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
7. ***dl6iak**.ba-karlsruhe.de*

Band pass filters for Top band - 160 m by YU1LM/QRP

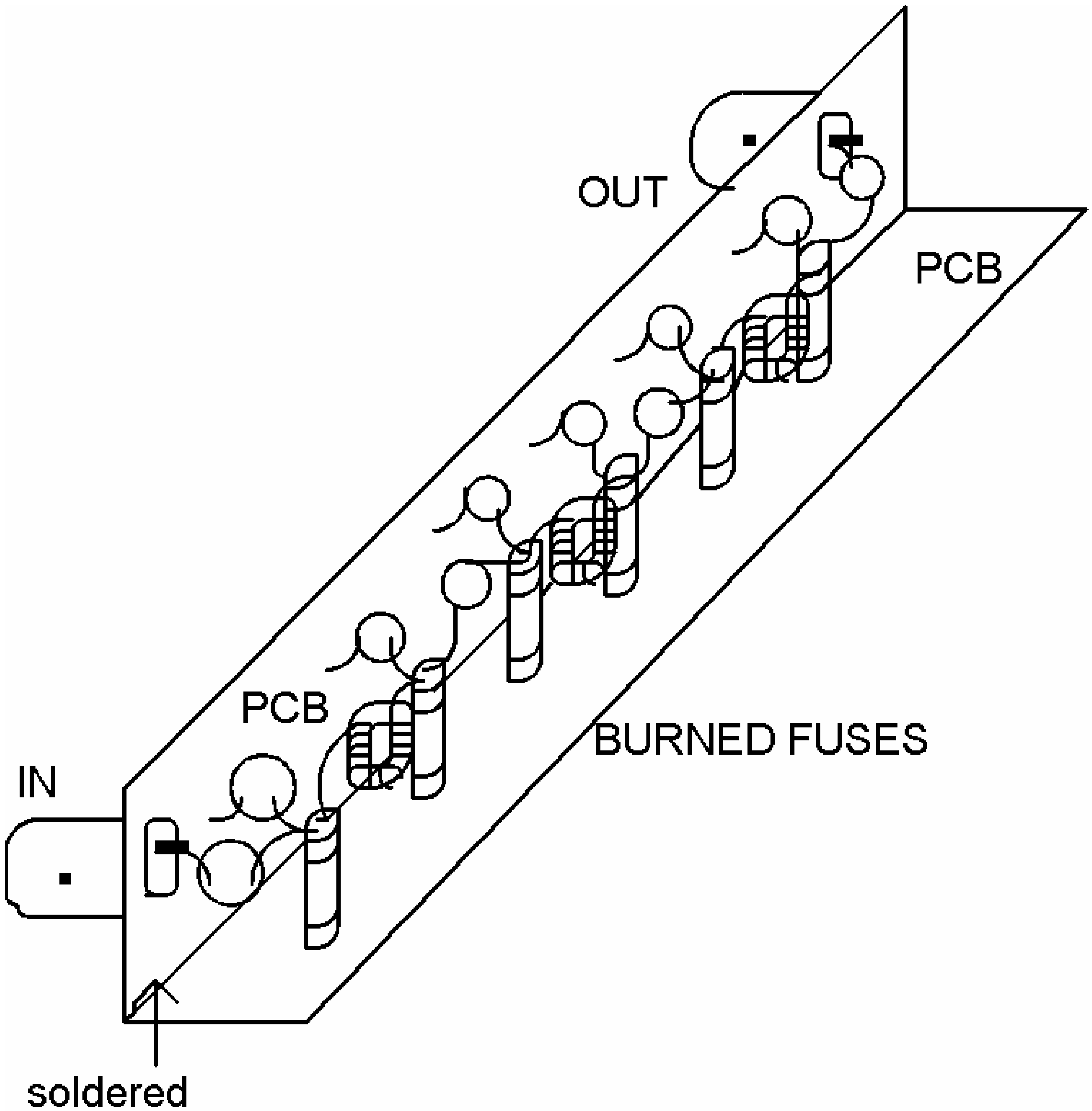
Top band (160m) is band with a lot of problems for HAMs who are working on them. A lot of signals from close MW very strong transmitters are producing IMDs and they unable receiving very weak HAM signals. This situation is real challenge for top band receivers. To improve receivers IMD performances one possible solution, except good antenna systems, is sharp band pass filter. This is my proposal and design to help in improving receiver selectivity and IMD specification. This design I made as help to Michel ON7EH who asked me to do this.



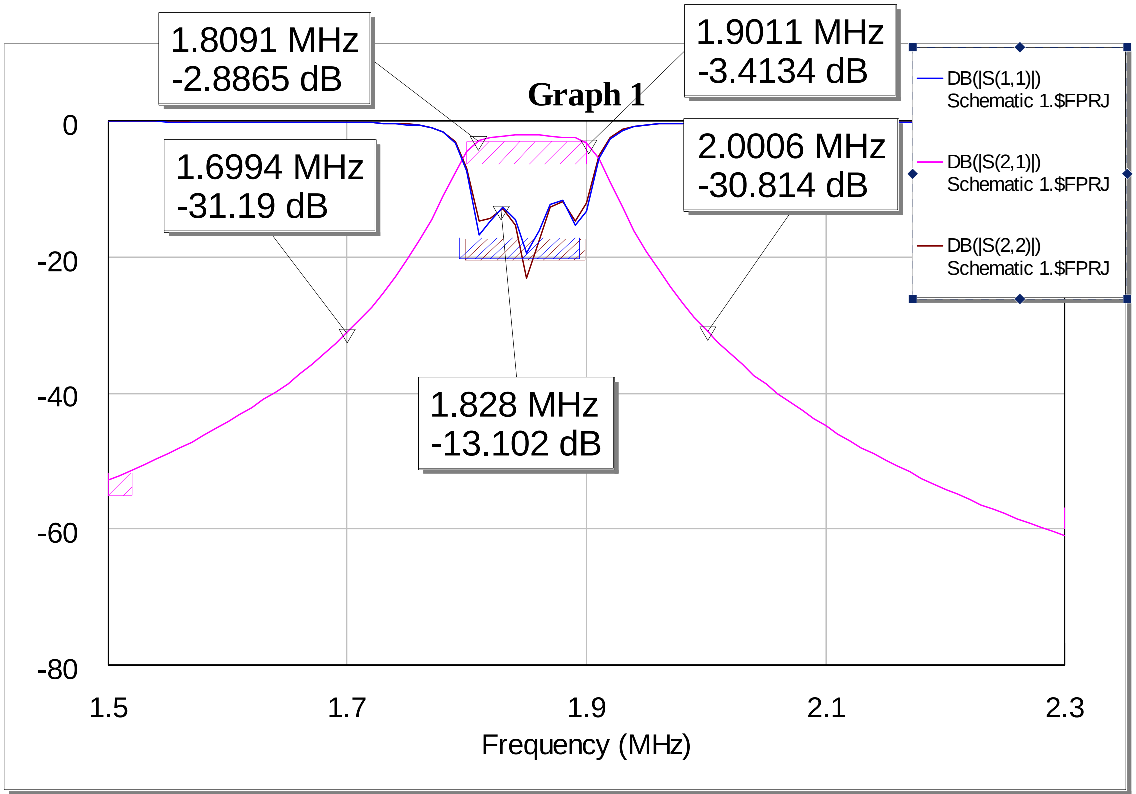
All components is better than 5 % tolerance

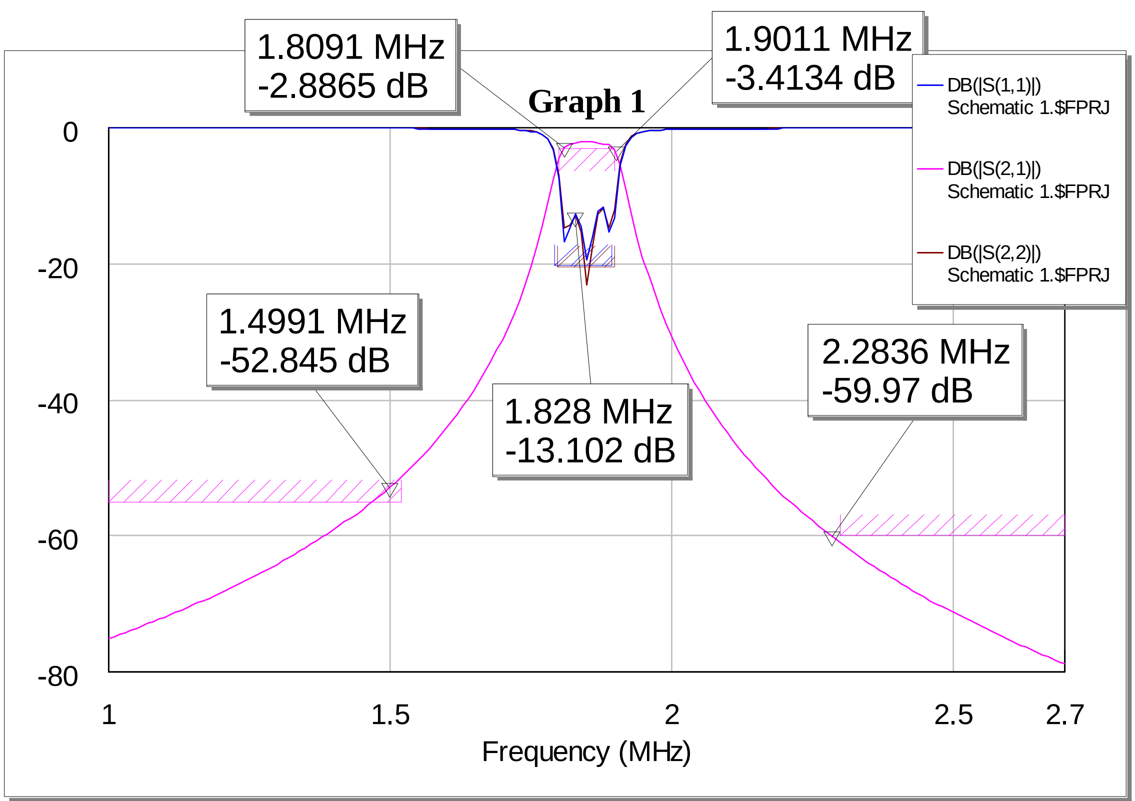
L=12 uH 49 turn 0.2 mm CuL on Amidon T 50-2 RED

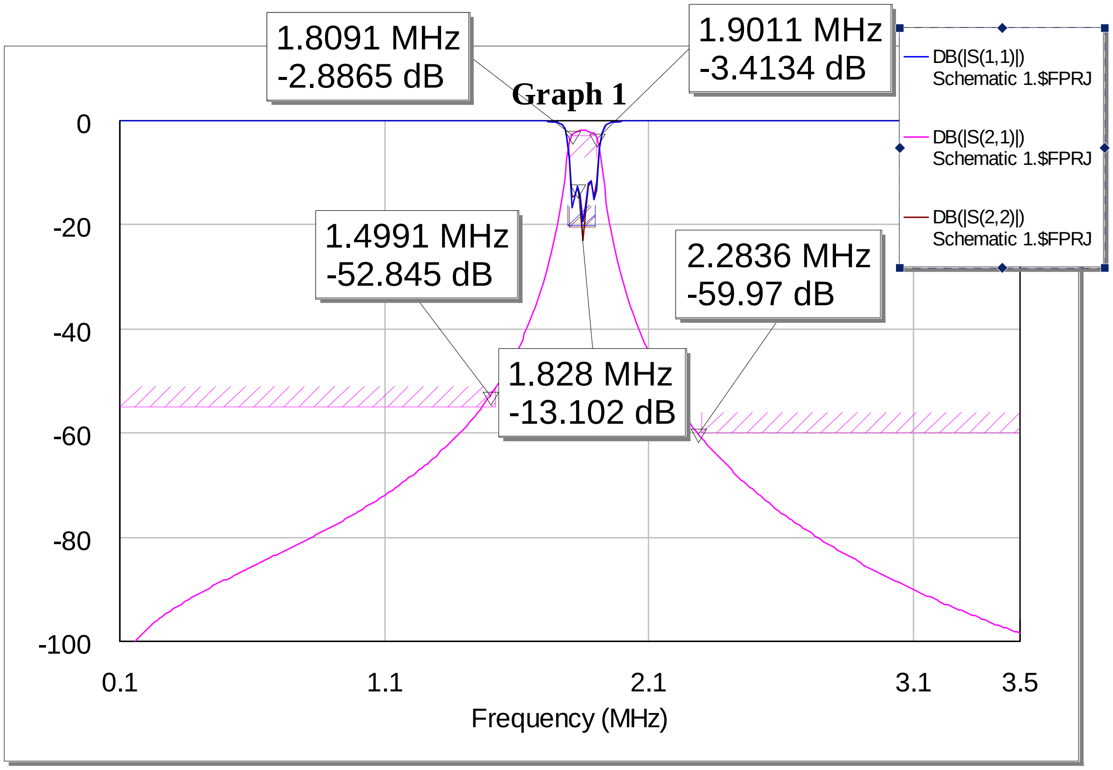
Practical realization my proposal

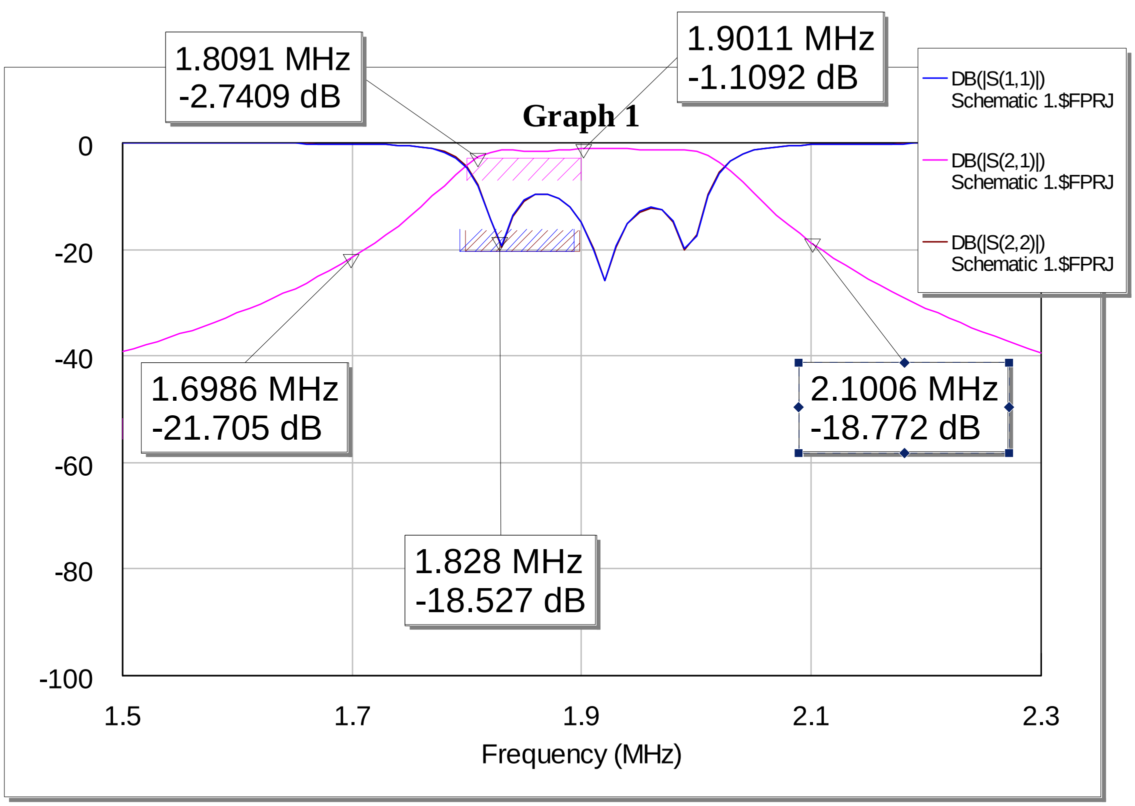


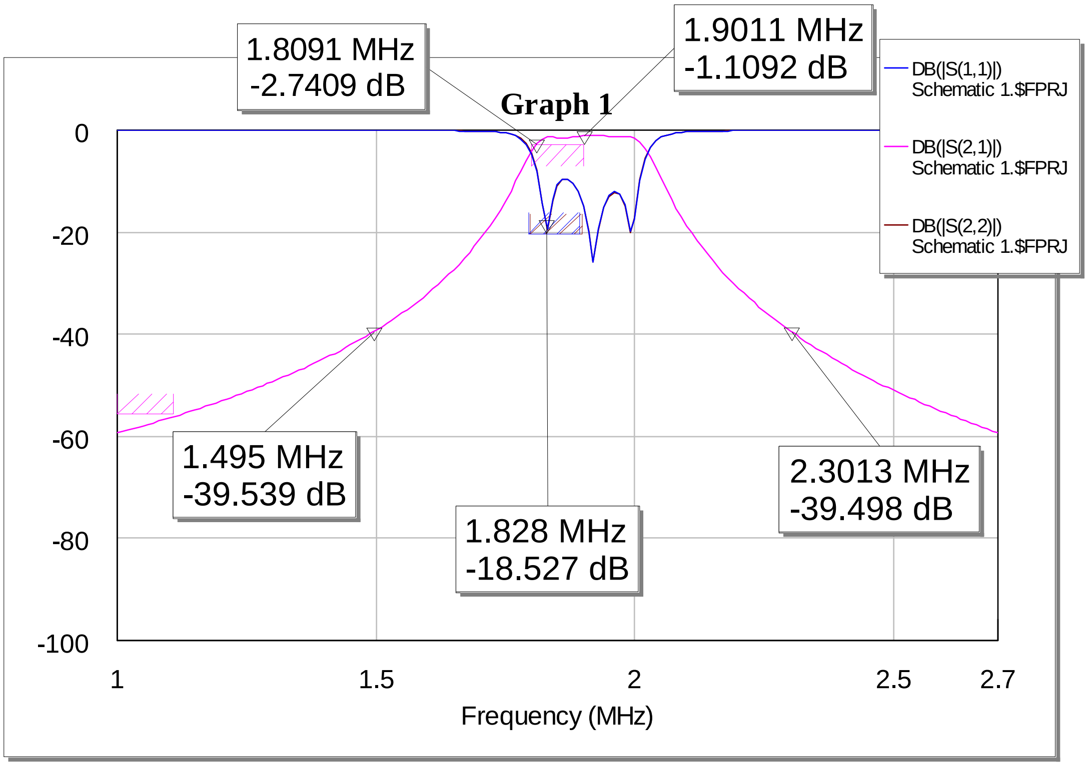
Frequency response for filters respectively


Graph 1
1.8091 MHz
-2.8865 dB
1.9011 MHz
-3.4134 dB
1.6994 MHz
-31.19 dB
2.0006 MHz
-30.814 dB
1.828 MHz
-13.102 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
0
-20
-40
-60
-80
1.5
1.7
1.9
2.1
2.3
Frequency (MHz)

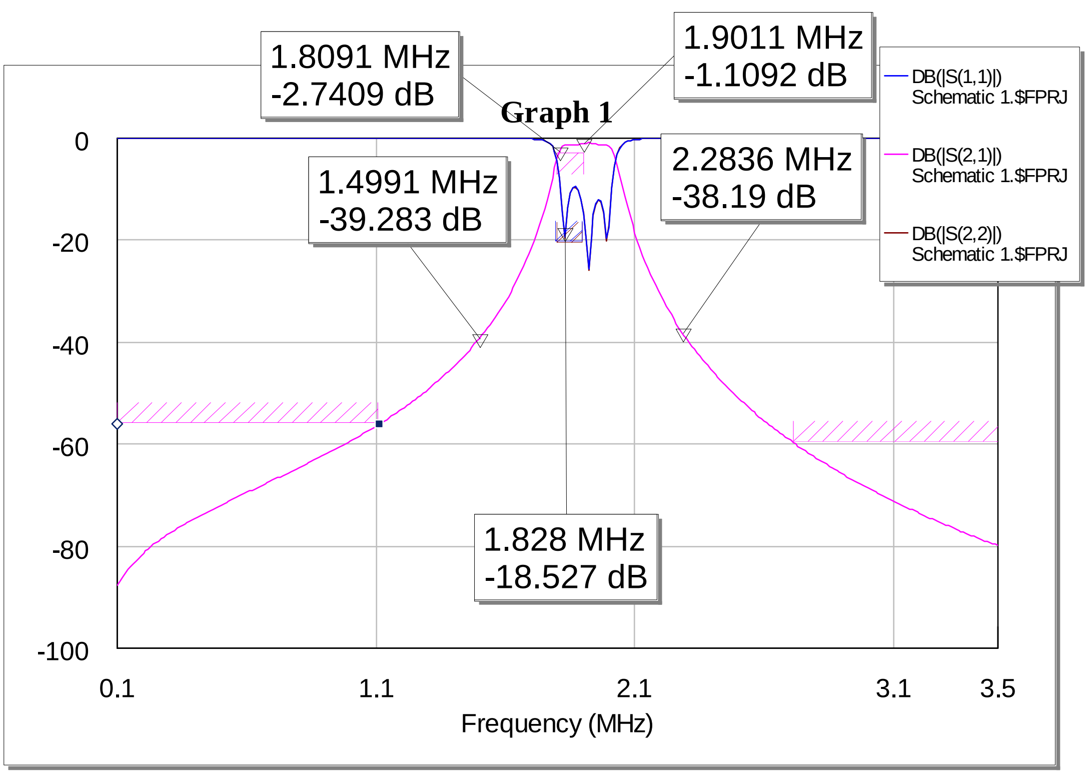

Graph 1
1.8091 MHz
-2.8865 dB
1.9011 MHz
-3.4134 dB
1.4991 MHz
-52.845 dB
1.828 MHz
-13.102 dB
2.2836 MHz
-59.97 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
0
-20
-40
-60
-80
1
1.5
2
2.5
2.7
Frequency (MHz)


Graph 1
1.8091 MHz
-2.8865 dB
1.9011 MHz
-3.4134 dB
1.4991 MHz
-52.845 dB
2.2836 MHz
-59.97 dB
1.828 MHz
-13.102 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
0
-20
-40
-60
-80
-100
0.1
1.1
2.1
3.1
3.5
Frequency (MHz)


Graph 1
1.8091 MHz
-2.7409 dB
1.9011 MHz
-1.1092 dB
1.6986 MHz
-21.705 dB
2.1006 MHz
-18.772 dB
1.828 MHz
-18.527 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
0
-20
-40
-60
-80
-100
1.5
1.7
1.9
2.1
2.3
Frequency (MHz)

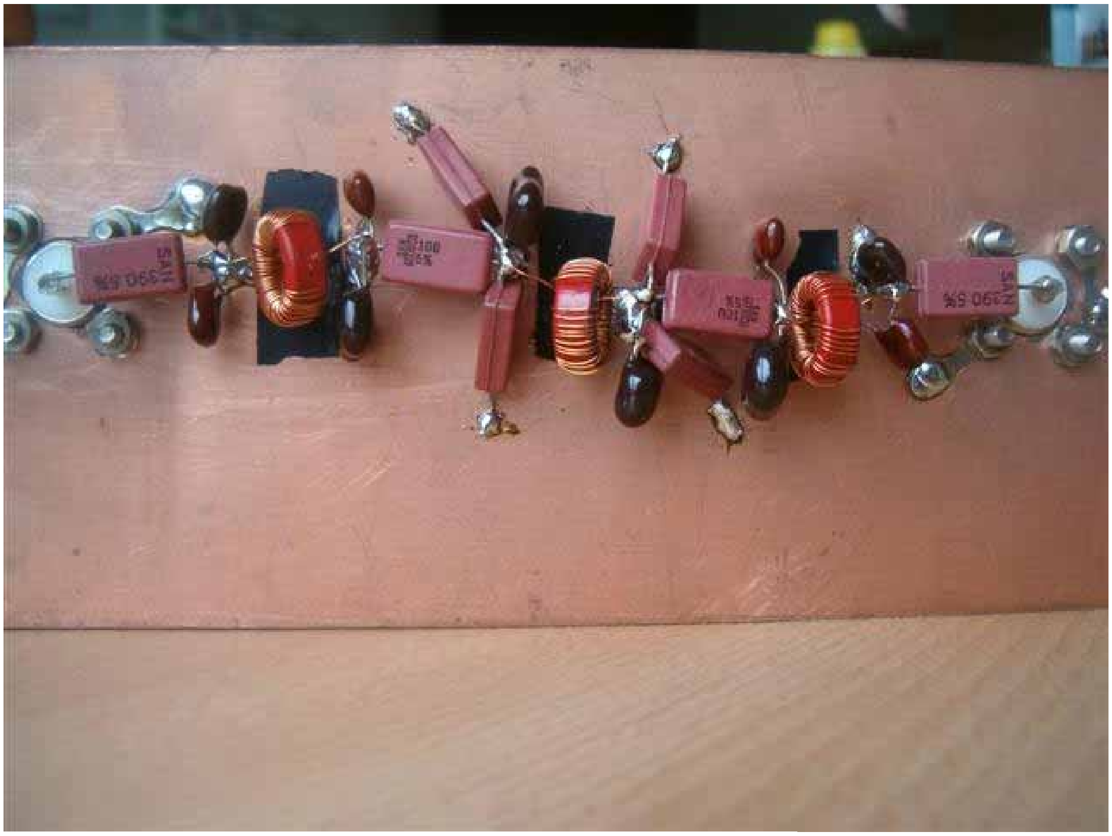


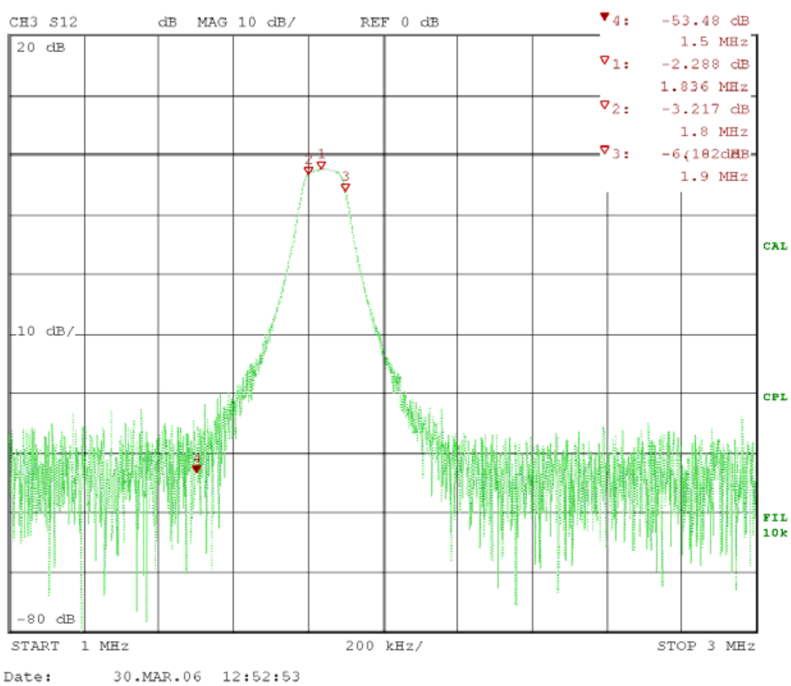
Graph 1
1.8091 MHz
-2.7409 dB
1.9011 MHz
-1.1092 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
1.495 MHz
-39.539 dB
1.828 MHz
-18.527 dB
2.3013 MHz
-39.498 dB
0
-20
-40
-60
-80
-100
1
1.5
2
2.5
2.7
Frequency (MHz)

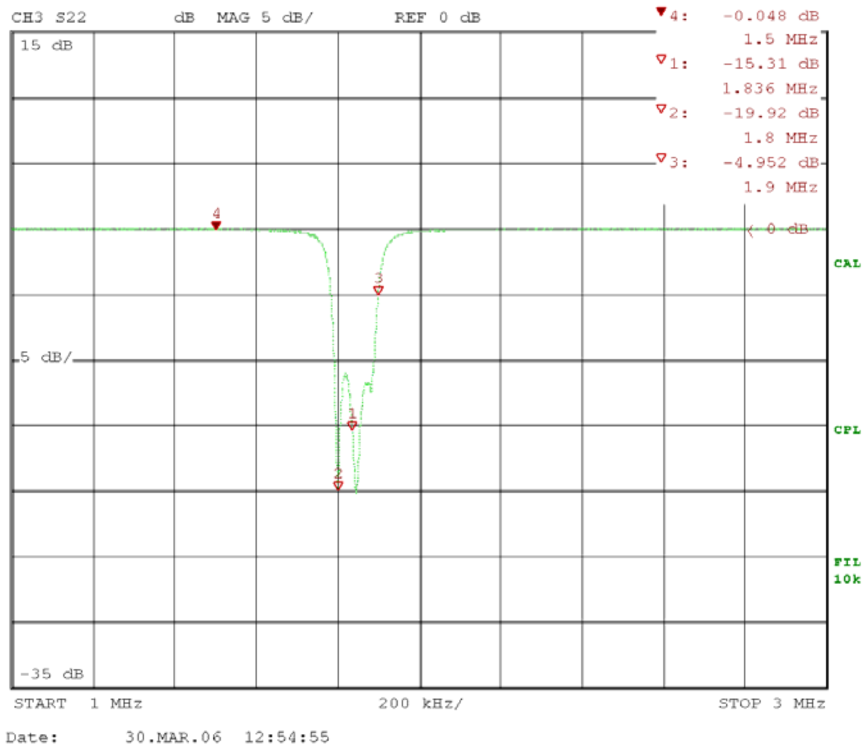


Graph 1
1.8091 MHz
-2.7409 dB
1.9011 MHz
-1.1092 dB
DB(|S(1,1)|)
Schematic 1.$FPRJ
DB(|S(2,1)|)
Schematic 1.$FPRJ
DB(|S(2,2)|)
Schematic 1.$FPRJ
1.4991 MHz
-39.283 dB
2.2836 MHz
-38.19 dB
1.828 MHz
-18.527 dB
0
-20
-40
-60
-80
-100
0.1
1.1
2.1
3.1
3.5
Frequency (MHz)

Michel ON7EH measurements on network analyzer see his prototype and response below:






CH3 S22 dB MAG 5 dB/ REF 0 dB
4: -0.048 dB
1.5 MHz
1: -15.31 dB
1.836 MHz
2: -19.92 dB
1.8 MHz
3: -4.952 dB
1.9 MHz
15 dB
5 dB/
-35 dB
0 dB
CAL
CPL
FIL
10k
START 1 MHz
200 kHz/
STOP 3 MHz
Date: 30.MAR.06 12:54:55

HF SDR S/H Sample and Hold Receiver with possibility to receive 3 bands harmonically related with single oscillator – DR3X is going from 30 KHz to 35 MHz-Make it Simple as Possible with Outstanding Performances

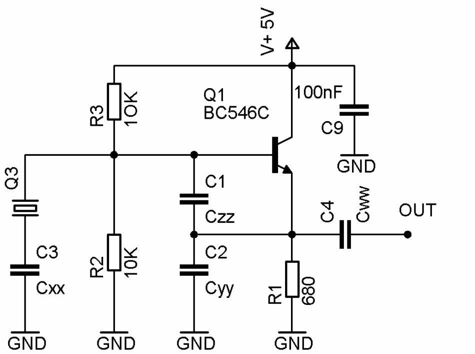
Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. you can see some photos on my sites and I can noticed that they are all mainly satisfied with results . Simple constructions with cheap classic components working really very well. Also I find at INTERNET that some solutions from my receivers/transmitters are used in some new SDR projects.

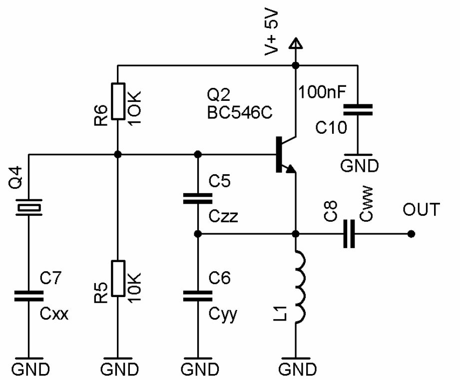
I made some local demonstrations of my SDR projects in Belgrade also. Presentation was for KKE club in YU1EXY club Audience was very surprised with very good received/ demodulated sound quality, crisp and clear sound like HI-FI (high fidelity) not common for the most commercial RIGs. SDR possibilities such as adjustable selectivity, noise reduction, NB noise blanker; waterfall… was discovery for most of them..But HAMs first excitements with new SDR techniques ware replaced with some disappointment because most HAMs like to tune LO (local oscillator) all over the working band or bands and they are not satisfied with +/- 20 KHz with fixed LO. Also some easy obtainable XTAL quartz or OSC are not in very interesting parts of HF HAM bands.. I decided to change this situation if it is possible. In meanwhile I made some experiments how to simplify my simple SDR construction with even simpler and cheaper design. Result is HF SDR S/H receivers DR2C and new DR3X which with ones single LO or XTAL enable 3 bands harmonically related receiving. Lets back to the past. I didn't experimenting with 74HC4053 at the beginning because 74HC4053 has higher Rds ON than 74HC4066. ON resistance for 74HC4053 is in range from 60-90 OHms. Also Leif SM5BSZ in his articles wrote that is not good IC like 74HC4052. My bad experience with 74HC4052 and his frequency limit as I explained in my articles on this site presentation previously stoped me to think about 74HC4053 as some possible IC for SDR design. Experimenting with DR2C receiver I noticed that 74HC4053 is very good IC little worse compared to the 74 HC4066 but still with very well and respectively performances. Also RX IC connections are much simpler than with 74HC4066 IC and it is necessary only 2 (two) 90 DEG square signals for driving switches.

I am using optimum technique to obtaining I/Q 90 DEG branches for driving CMOS switches with double D FF 74AC74 for max input frequency of 74HC4053. In this situation give us that we have 4 times higher LO (local oscillator) frequency than receiving frequency is . Advantage of using 50/50 % duty cycle technique I explained in previously articles. Advantage is evident very much in my SDR transmission projects DT1, DT2 and DT2A and new SDR low power transceiver ADTRX1. In receivers this 50/50 % ratio is not so important like for the transmission. 50/50 % driving LO signals will increase max input frequencies with used ICs hardware realization.

. This mean that is possible satisfactory receiving with relative good image rejection almost in all HAM bands to the 35 MHz .Input frequency 35 MHz is very close to the upper limit for 74HC4053 IC around 55-60 MHz .In oscillator schematic down with tables I proposed some values for oscillators which are working in fundamental or overtone mode. Components placement are done for all 3 possibilities first for fundamental XTAL quartz OSC, than overtone XTAL quartz OSC and external LO connection. In schematic for fundamental mode oscillator XTAL quartz will oscillate to the 30 MHz . In schematic with coil Lxx oscillator will work with overtone quartz to the max frequencies 100-120 MHz!



FUNDAMENTAL MODE OSCILLATOR

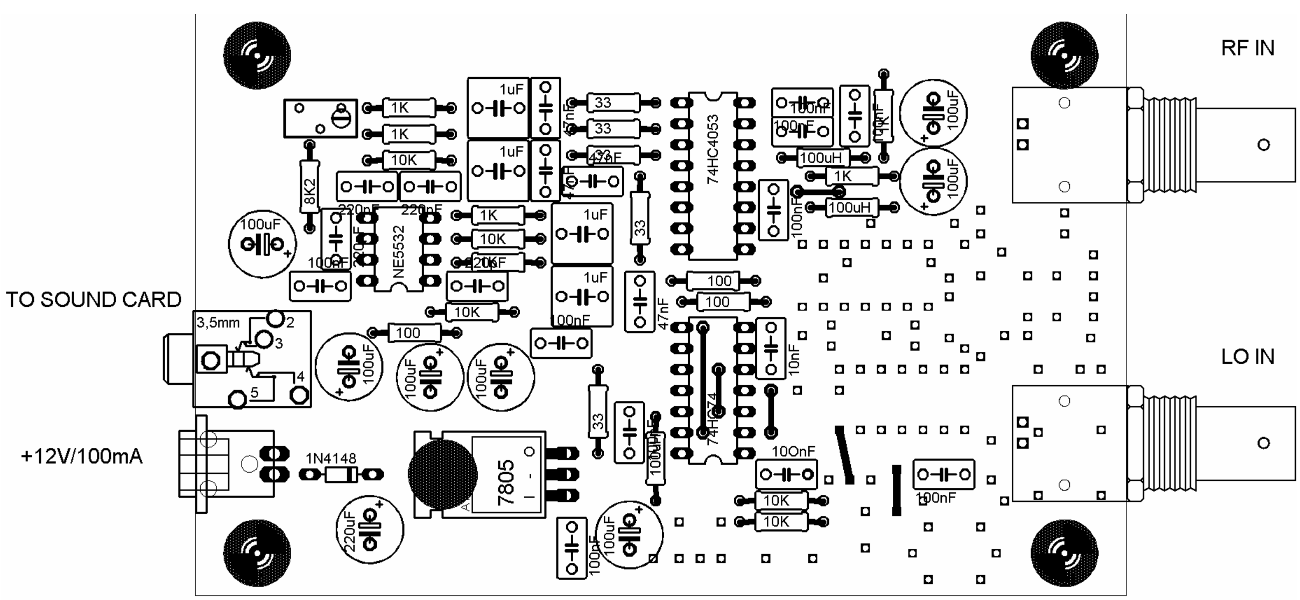


OVERTONE MODE OSCILLATOR

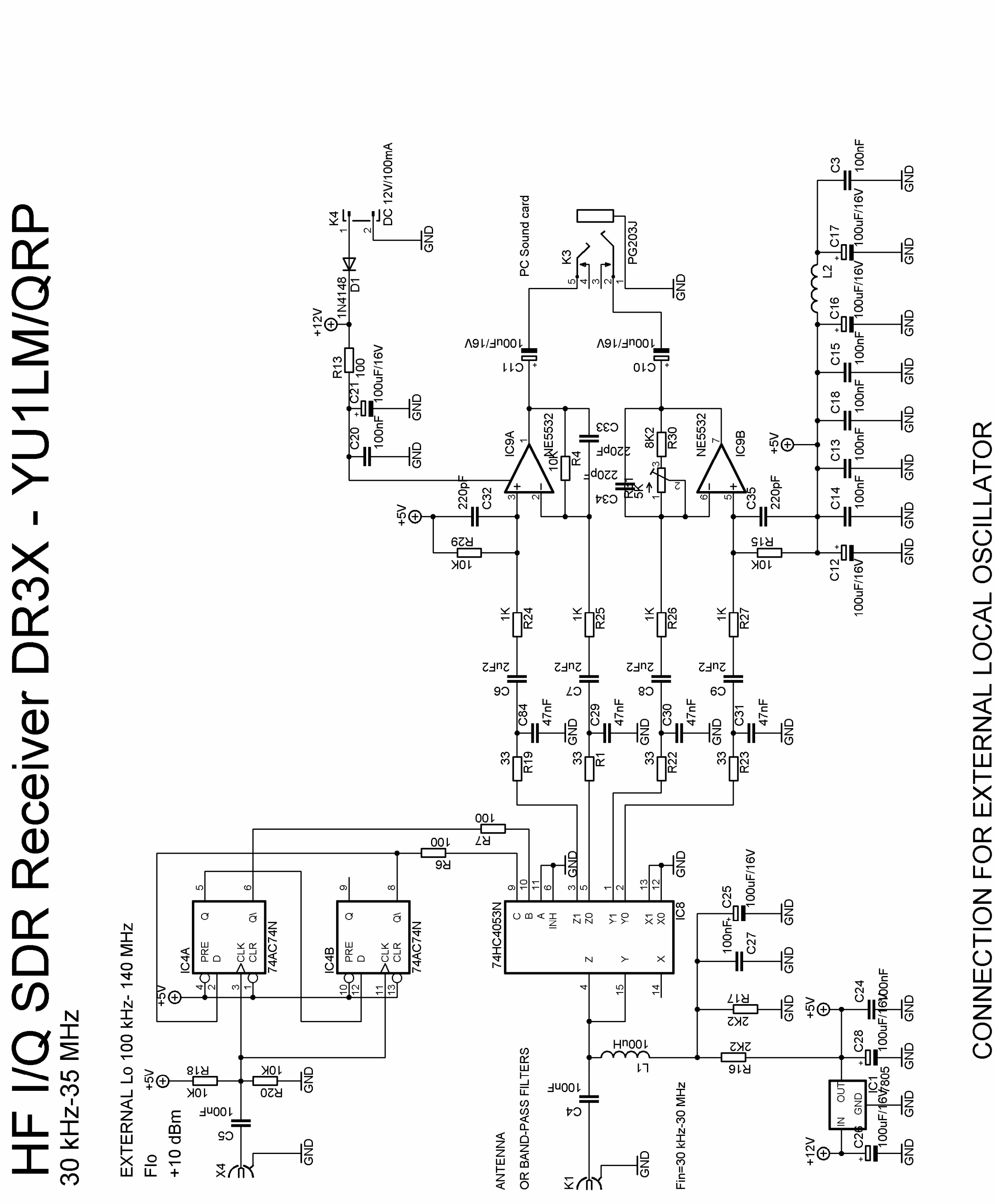
F [MHz]	Cxx [pF]	Cyy [pF]	Czz [pF]	Cww [pF]
2-4	0-33	330	680	220
2-15	0-33	220	470	100
10-30	0-33	100	220	56

F [MHz]	Cxx [pF]	Cyy [pF]	Czz [pF]	Cww [pF]	Lxx [nH]
28-60	0-33	22	47	22	~330
40-80	0-33	18	33	18	~220
70-110	0-33	15	33	15	~100

BC546C is possible substitute with any other TUN transistor with fT>=150 MHz. All values in tables are only for orientation especially Lxx which is for fine tune.

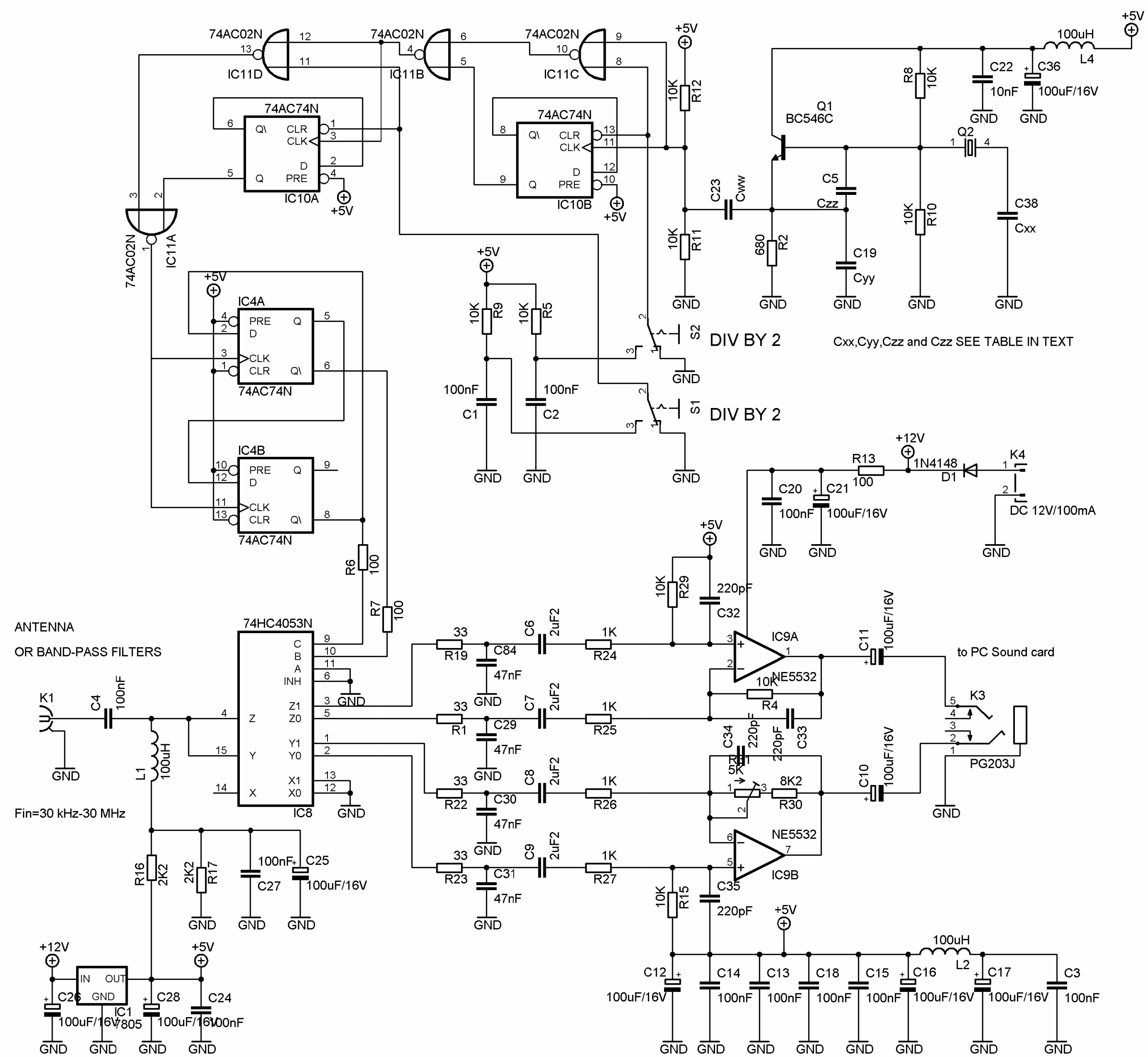


DR3X part placement for external local oscillator connection to 140 MHz with Vcc=+6V and 74AC74

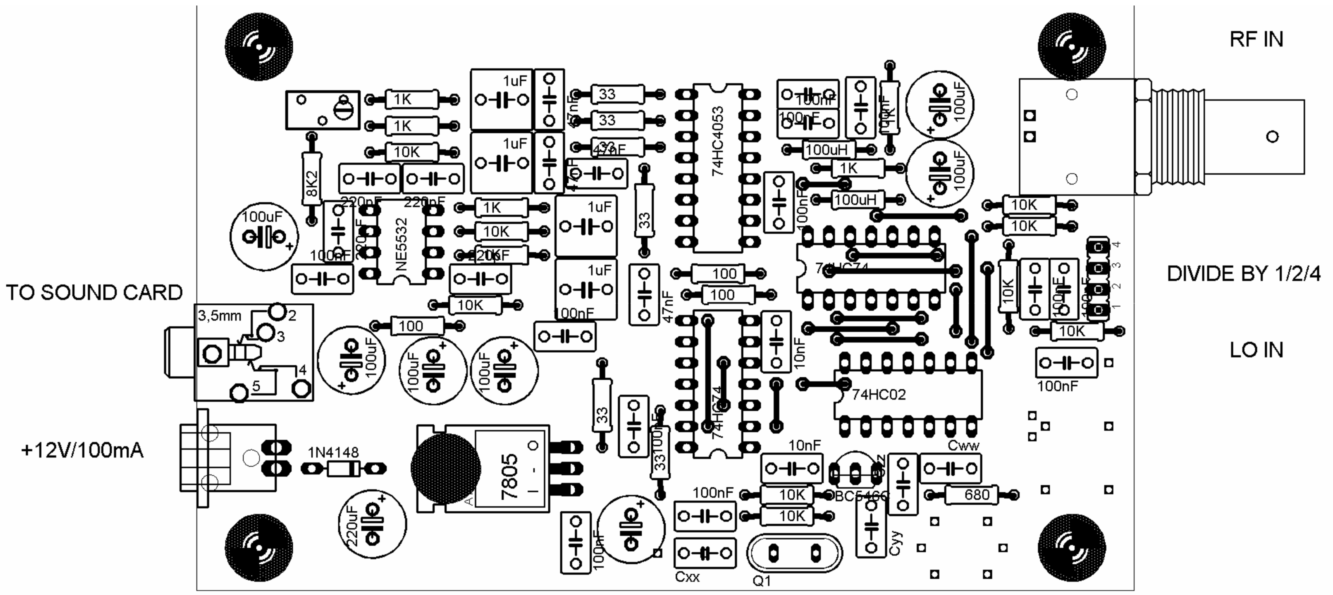


HF I/Q SDR Receiver DR3X - YU1LM/QRP

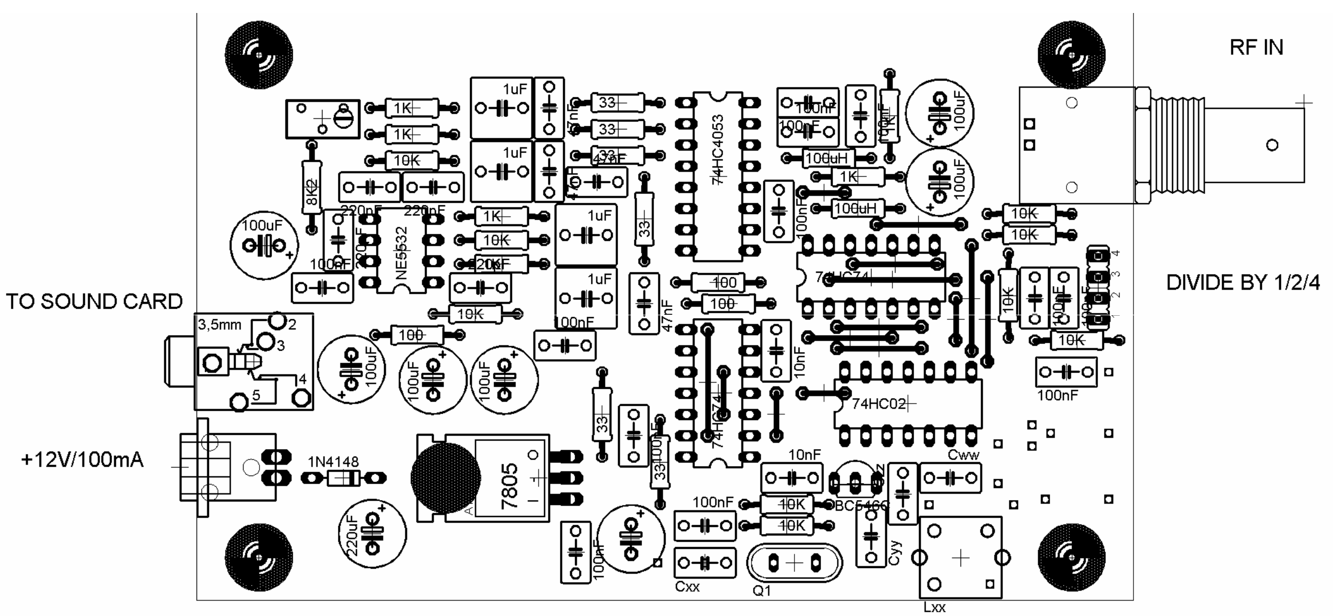
30 kHz-30MHz



CONNECTION FOR FUNDAMENTAL OSCILLATOR MODE TO 30 MHz



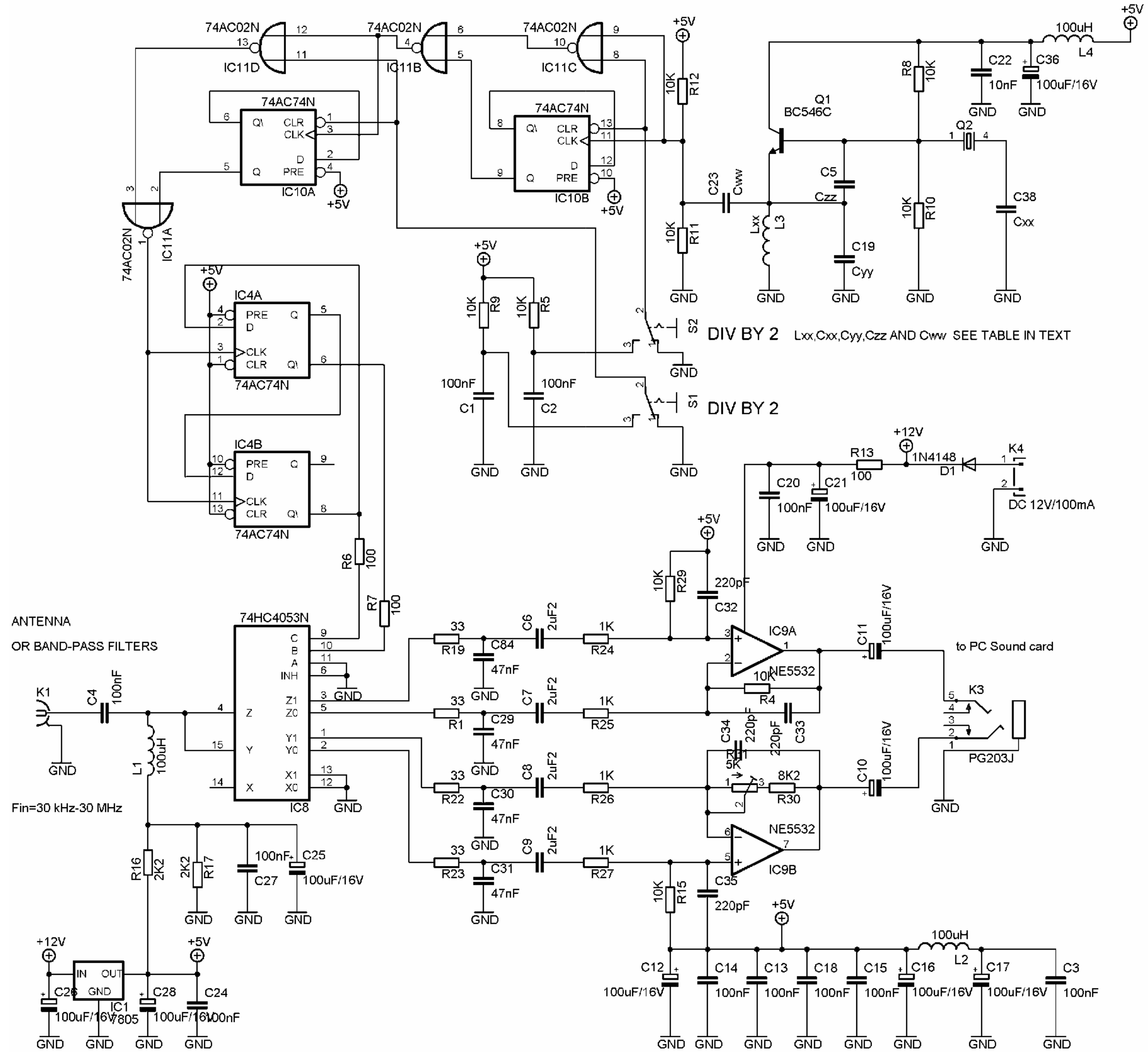
DR3X parts placement for fundamental mode oscillator to 30 MHz



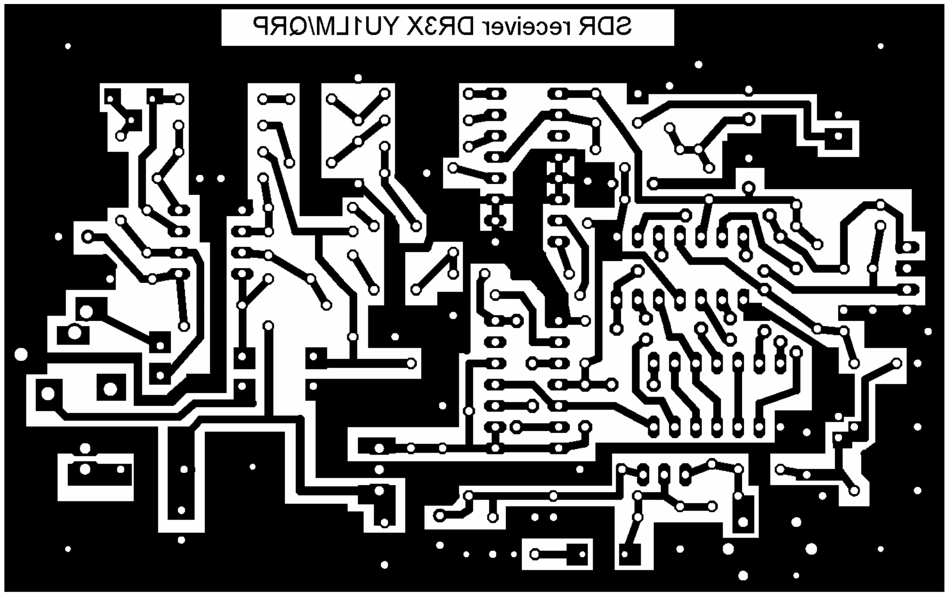
DR3X parts placement for overtone mode oscillator to 110 MHz with 74AC74

HF I/Q SDR Receiver DR3X - YU1LM/QRP

30 kHz-30MHz



CONNECTION FOR OVERTONE OSCILLATOR MODE



Single side PCB size is 112.5 x 70 mm

Measuring results which I made with HF S/H SDR receiver DR3X

1. Receiving range from 30 kHz to 35 MHz (with Q unit oscillator it is limited to the 30 MHz). With one XTAL 56.1 MHz it is possible to receive +/- 20 kHz around next frequencies 14.025 MHz, 7.0125 MHz and 3.507 MHz Bands are harmonically related. Max receiving frequency is achiving with external LO and Vcc=+6 V for digital ICs.
2. IIP3 27-29 dBm and it depends from setting and used programs (all with 16 bit sound cards).
3. MDS -102-105 dBm also with 16 bit SB card Realtek AC97
4. Image rejection is possible adjust to 35-60 dB 12 kHz from center frequency.
5. Sensitivity 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 70 dB. This sensitivity is more than enough for frequency near to 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain (10 Kohms increase to max 100 Kohms R4,R29,R30 and R15) or putting some RF preamplifier in front of DR3X to lower F (noise figure) of receiver.
6. SFDR (Spurious free dynamic range) is 86-92 dB, this results are with signals spaced 5 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more.

Some excellent performances with 3-5 IC are not without other side:

1. First and very big disadvantage is 4 times higher LO
2. Image rejection is changing through receiving bands and results are done for frequencies 12 kHz from central frequency
3. Harmonically bands are not always good choice. For example if we are using very frequent computer quarz 14.312 MHz we can receive +/- 20 kHz around 3.578 MHz,

1.789 MHz and 894.5 kHz middle frequency only touch beginning 160 m band and last one is out of any amateur bands.

4. For external LO it is necessary input level around 1 Vp-p min for safe operation (for lower LO drive operations are not sure especially for higher LO frequencies)!!!Simple test that 74HC4053 is working is to measure with DMM(dugital multimeter) Vcc/2 or 2.5 V +/-0.5 V at control pins 9 or 10. If it is not true we have a problem with input LO level or input ICs 74AC74 or 74AC02.

DR3X adjustments are simple and done in two steps:

1. Adjust with universal instruments DMM (digital multimeter) that is resistance in feedback potentiometer 5k +8K2 = 10 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal from signal generator to the input of DR3X and with 5 kOhm potentiometer adjust min unwanted image signal in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exist function such as skew in Alberto I2PHD programs.

I wish you successful DR3X realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP
tasa@imtel-mikrotalasi.co.yu

References:

1. ***www.qsl.net/yu1lm/homebrew***
2. ***http://forum.cqham.ru/viewforum.php ?f=28***
3. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
4. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
5. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
6. ***http://www.njqrp.org/mbrproj/9850dds.html***

www.analog.com/en/prod/0,,770_843_AD9850,00.html

http://www.qsl.net/pa3ckr/signalgenerator/

http://www.k6ese.com/DDS_Project.htm

http://ham.kiev.ua/pic/dds_ham2.html

http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

http://members.aol.com/Dl4JAL/DDS.html

http://hem.passagen.se/communication/dds.html

7. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

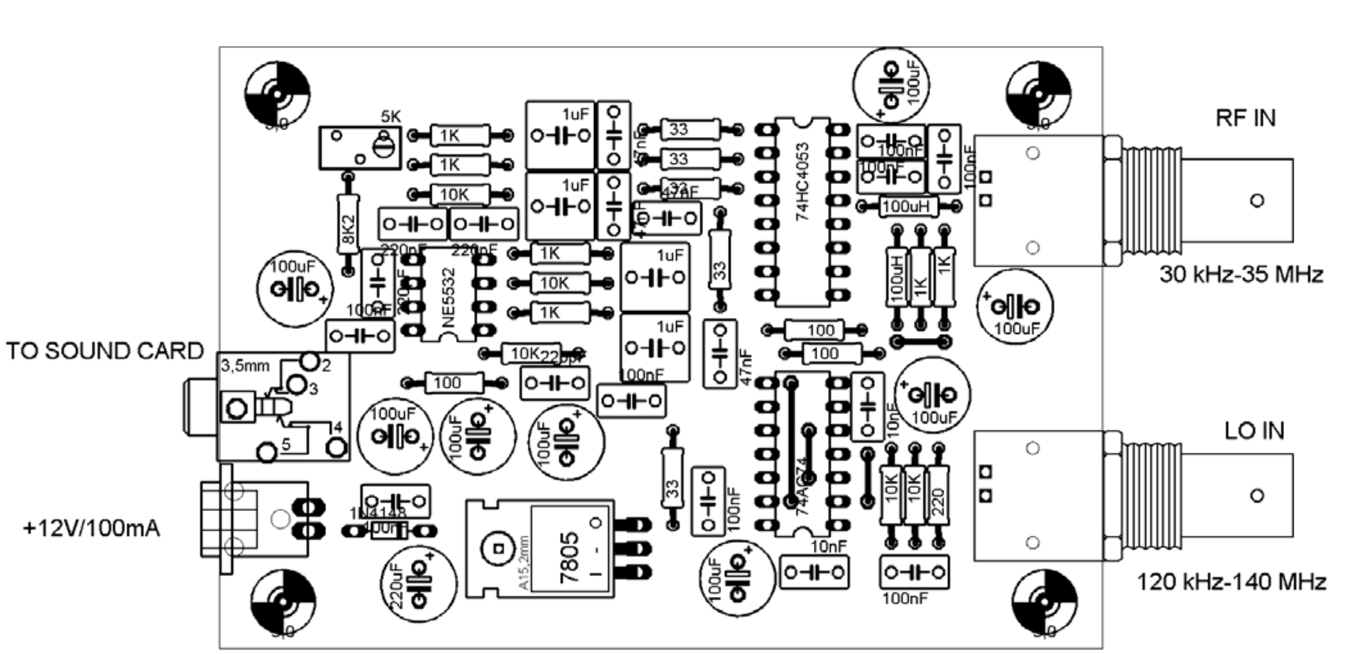
1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.99*

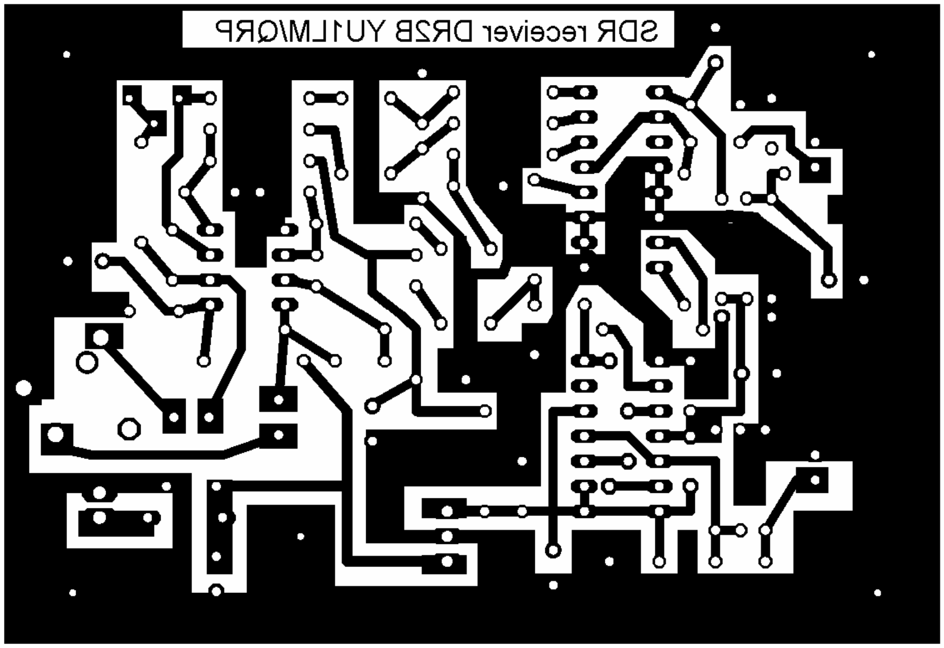
   www.qsl.net/i2phd Alberto I2PHDhttp://gpsdo.i2phd.com/
2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.weaksignals.com WINRAD*
4. *www.ciaoradio.com*
5. *www.m0kgk.co.uk/sdr*
6. *www.g8jcf.dyndns.org Peter G8JCF*
7. *http://www.nitehawk.com/sm5bsz Leif LINARD*
8. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
9. *dl6iak.ba-karlsruhe.de*

HF SDR S/H Sample and Hold Receiver DR2B from 30 KHz to 35 MHz-Make it Simple as Possible with Outstanding Performances

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. you can see some photos on my sites and I can noticed that they are all mainly satisfied with results . Simple constructions with cheap classic components working really very well. Also I find at INTERNET that some solutions from my receivers/transmitters are used in some new SDR projects. I made DR2B PCB as product from DR3X receiver .Here is one of 3 possible connection for DR3X for external local oscillator with new PCB very small compare to DR3X PCB .This receiver is similar very much to DR2 but even simpler. All data, measurements and adjustment are the same. I shall repeat it here. I am giving schematics, part placement and PCB.





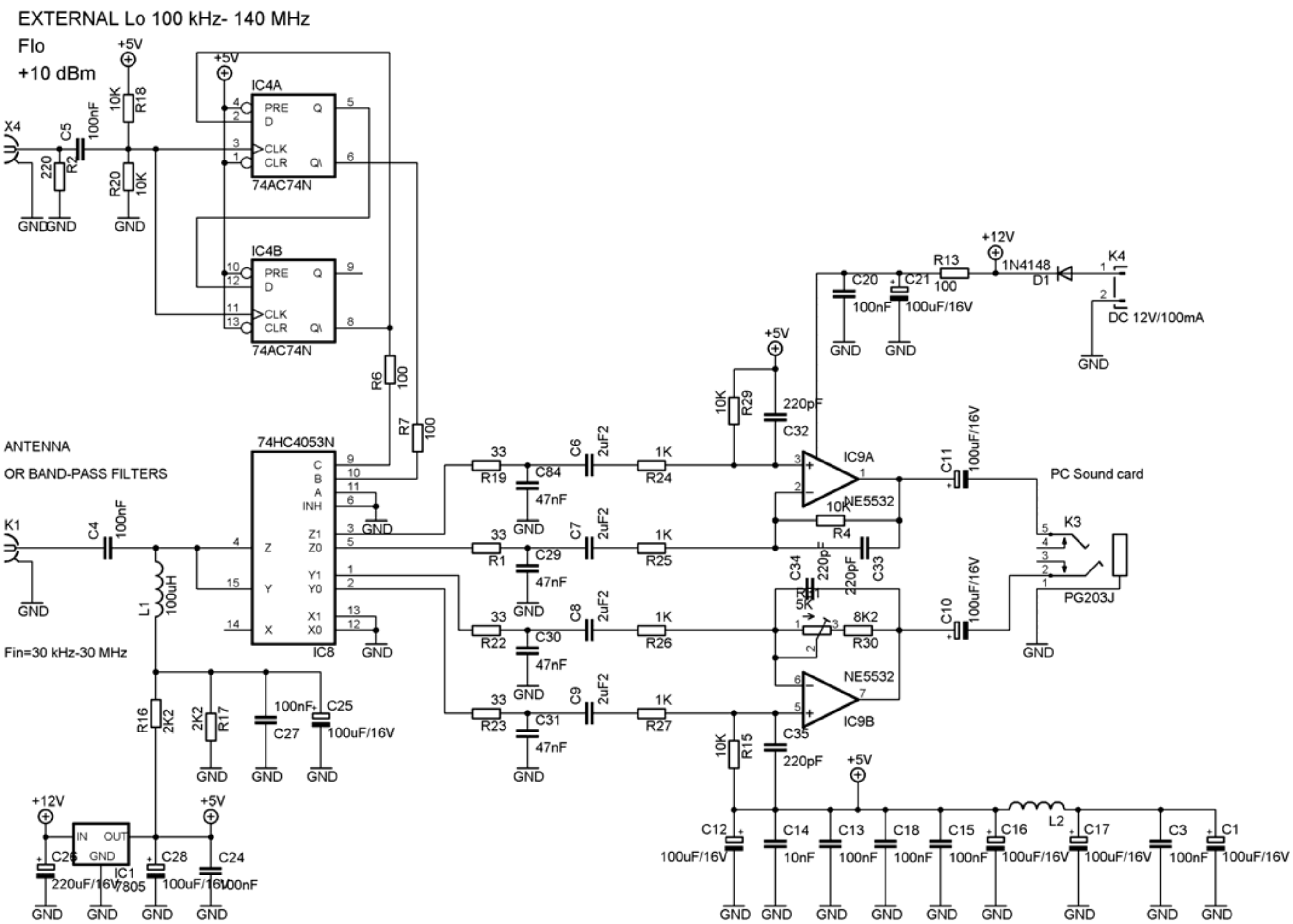
DR2B Single side PCB size is 95 x 65 mm

Measuring results which I made with HF S/H SDR receiver DR2B

1. Receiving range from 30 kHz to 35 MHz with external LO and Vcc=+6 V for digital ICs.
2. IIP3 27-29 dBm and it depends from setting and used programs (all with 16 bit sound cards).
3. MDS -102-105 dBm also with 16 bit SB card Realtek AC97
4. Image rejection is possible adjust to 35-60 dB 12 kHz from center frequency.
5. Sensitivity 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 70 dB. This sensitivity is more than enough for frequency near to 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain (10 Kohms increase to increase to max 100 Kohms R4,R29,R30 and R15) or putting some RF preamplifier in front of DR2B to lower F (noise figure) of receiver.
6. SFDR (Spurious free dynamic range) is 86-92 dB, this results are with signals spaced 5 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more.

HF I/Q SDR Receiver DR2B - YU1LM/QRP

30 kHz-35 MHz



CONNECTION FOR EXTERNAL LOCAL OSCILLATOR

Some excellent performances with 3 IC are not without other side:

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DR2B adjustments are simple and done in two steps:

1. Adjust with universal instruments DMM (digital multi meter) that is resistance in feedback potentiometer 5k +8K2 = 10 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal from signal generator to the input of DR2B and with 5 kOhm potentiometer adjust min unwanted image signal in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.

I wish you successful DR2B realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP
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http://www.seboldt.net/k0jd/othervfo.html

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1. ***http://digilander.libero.it/i2phd/*** ***SDRadio software ver 0.99***

   www.qsl.net/i2phd ***Alberto I2PHDhttp://gpsdo.i2phd.com/***

2. ***ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio***
3. ***www.weaksignals.com*** ***WINRAD***
4. ***www.ciaoradio.com***
5. ***www.m0kgk.co.uk/sdr***
6. ***www.g8jcf.dyndns.org*** ***Peter G8JCF***
7. ***http://www.nitehawk.com/sm5bsz*** ***Leif LINARD***
8. ***http://www.flex-radio.com*** ***SDR1000 Gerald AC5OG***
9. ***dl6iak.ba-karlsruhe.de***

Monoband SDR HF S/H Sample and Hold Receiver with LO at working frequency - DR2C from 30 KHz to 50 MHz-Make it Simple as Possible with Outstanding performances

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. you can see some photos on my sites and I can noticed that they are all satisfied with results . Simple constructions with cheap classic components working really very well. Also I find at INTERNET that some solutions from my receivers/transmitters are used in some new SDR projects.

I made local demonstrations of my SDR projects here in Belgrade. Presentation was for KKE club in YU1EXY club. Audience was very surprised with very good received demodulated signal quality, crisp and clear sound like HI-FI (high fidelity) not common for the most commercial RIGs. SDR possibilities such as adjustable selectivity, noise reduction, NB noise blanker; waterfall… was discovery for most of them. Local HAMs first excitements with new SDR techniques ware replaced with some disappointment because most HAMs like to tune LO (local oscillator) all over the working band and they are not satisfied with +/- 20 KHz with fixed LO. Also some easy obtainable XTAL quartz or OSC are not in very interesting parts of HF HAM bands. It is not easy build or it wasn't easy to build ever stabile LO at 120 MHz for 30 MHz or 56 MHz for 14 MHz. DDS LO is not easy to build for most builders also, a lot of reasons: hard to find IC-s, expensive and SMD components, needs for precise PCB for IC soldering…. Other solutions like PLLs are not so easy for realization also. In meanwhile I made some experiments how to simplify my simple SDR construction with even simpler and cheaper design. I decided to try new SDR design with some other IC and make SDR closer to HAM which like to try new technique with less problems cased with high LO frequencies. Result is HF SDR S/H receiver DR3X one LO or XTAL enable 3 bands harmonically related receiving.

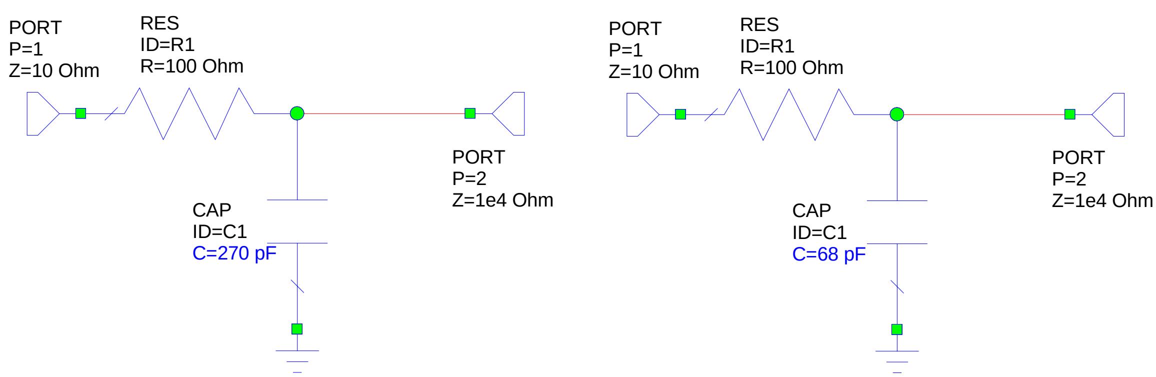
I also decided to try some not optimum technique obtaining I/Q 90 DEG branches for driving CMOS switches ref2 instead better technique with double D FF 74AC74 for max input frequency . Advantage of using 50/50 % duty cycle technique I explained in previously articles. Advantage is evident very much in my SDR transmission projects DT1, DT2 and DT2A. In receivers this 50/50 % ratio is not so important like for the transmission except for increasing max input frequencies with used hardware realization.

Here is a new one monoband HF SDR S/H receiver called DR2C with LO at receiving frequency from 30 KHz to 50 MHz. 90 DEG shift is obtaining with RC LP (low pass) network. What is very important for design it is gate output impedance which is driving RC networks is small as possible. At that way its output impedance influence to 90 deg phase shift is small as possible. Because of that I paralleled 3 inverters 74HC04 to decrease output impedance. It is important that is at output first inverter duty cycle close to optimum 50/50 % also. This is easy obtain able with clear sinusoidal drive signal with high amplitude 1 Vp-p or more for example. This solution is frequency depending design Exactly 90 deg shift is only at one frequency but for some practical used bandwidth it is OK. This mean that is possible satisfactory receive with relative good image rejection almost in all HAM bands to 50 MHz .Change inside most band is under 1 DEG. This is very important if you like to try SDR technology in commercial RIG as new IF . Design is also temperature sensitive .There is some change in 1 or 0 logical levels with bigger temperature change for CMOS ICs. In normal temperature range or room temperature work phase change with temperature change is very small. To reduce this problem little help is 10 K resistor at input of invertors.

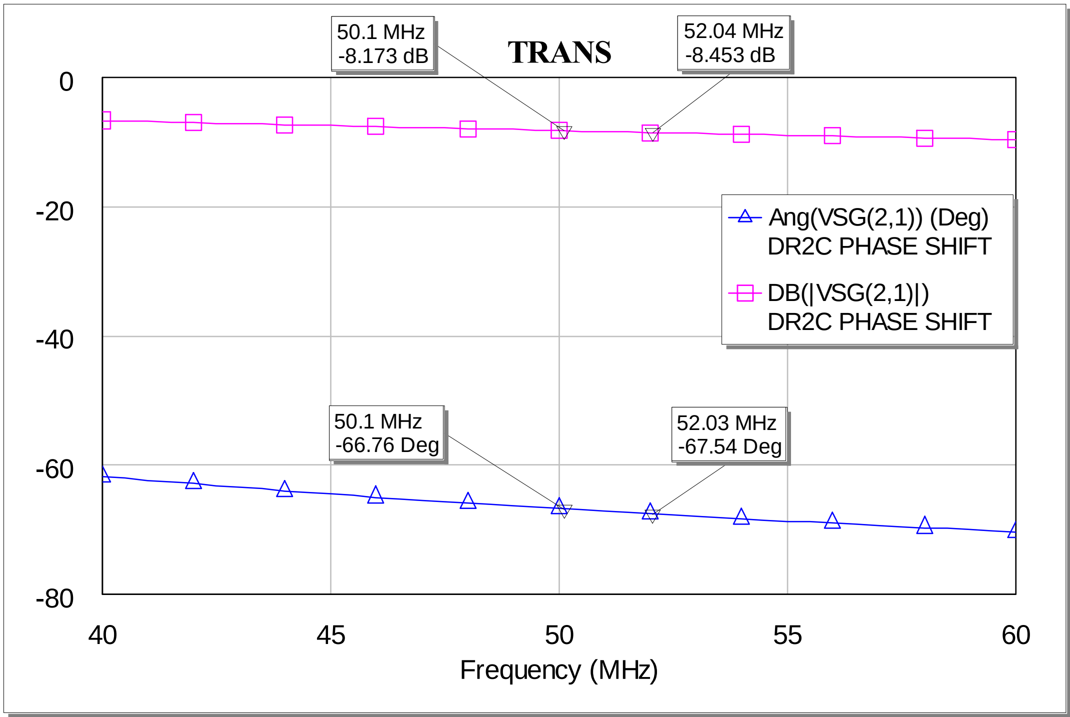
Solution for phase shift with increasing R have big disadvantage for higher HF frequencies shift capacitor C became small and close to parasitic C inside IC invertors. In schematic I proposed some values for all HAM bands to 50-60 MHz which is close to the upper limit for IC 74 HC 4053 but it is possible other different components combination also. Components placement is done first for all 3 possibilities together XTAL quartz OSC, DIL OSC and external LO connection. Individual. XTAL quartz OSC is working to 30 MHz this schematics will not working on overtone quartz frequencies and frequencies over 30 MHz! For the receiving frequencies over 30 MHz LO source is possible DIL oscillator or some external oscillator working to 50 MHz with levels min 0 dBm.

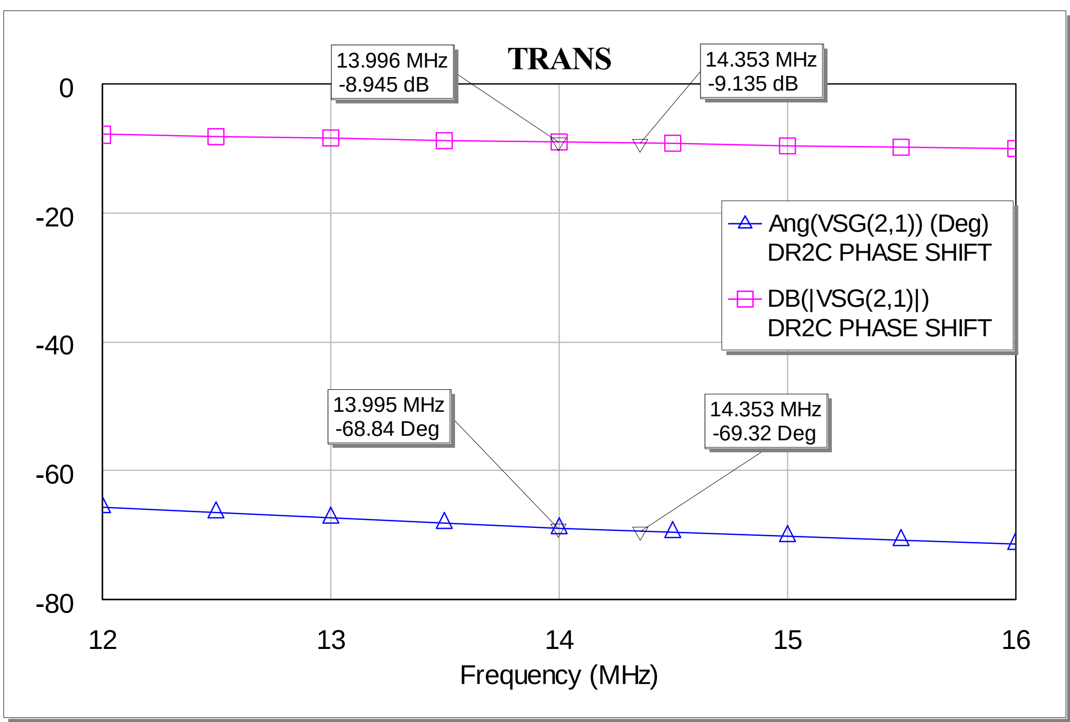
This design is ideal for build in inside some RX to obtain I/Q outputs for SDR sound card DSP processing. Carrier USB/LSB quartz can be easily move up 3-10 kHz with help C23. This mean that is LF IF in region 3-10 KHz that is enough to use I/Q with better success than ordinary AF sound card processing. Value for capacitor C23 is necessary to determine and obtain optimum max frequency shift and stabile oscillation at the same time.

RC Shift network are not shifting 90 DEG initially but shift is around 66 DEG. Signal which is coming to the inverter gate is not sinusoidal wave signal but close to saw signal .We have a DC level for changing inverter levels from 1 to 0 or vice versa also. Together we obtain 90 DEG. See simulation curves are done for 14 MHz and 50 MHz bands.

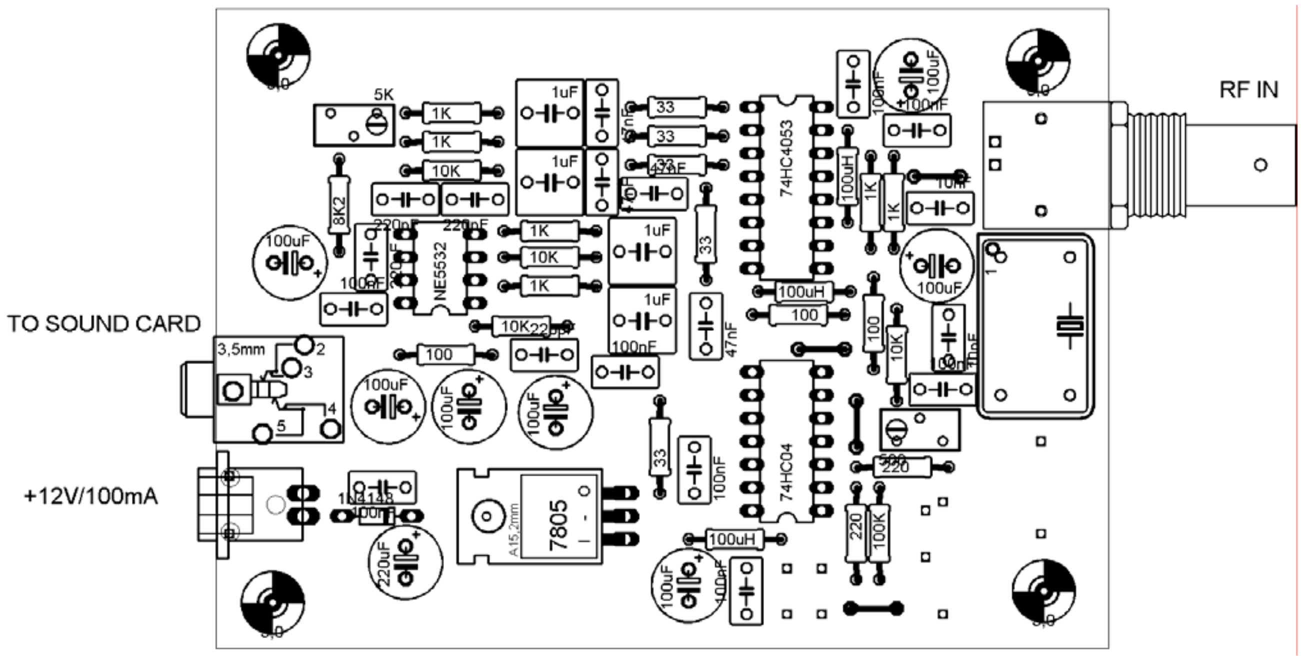


Values for phase sift network on 14 MHz and 50 MHz bands

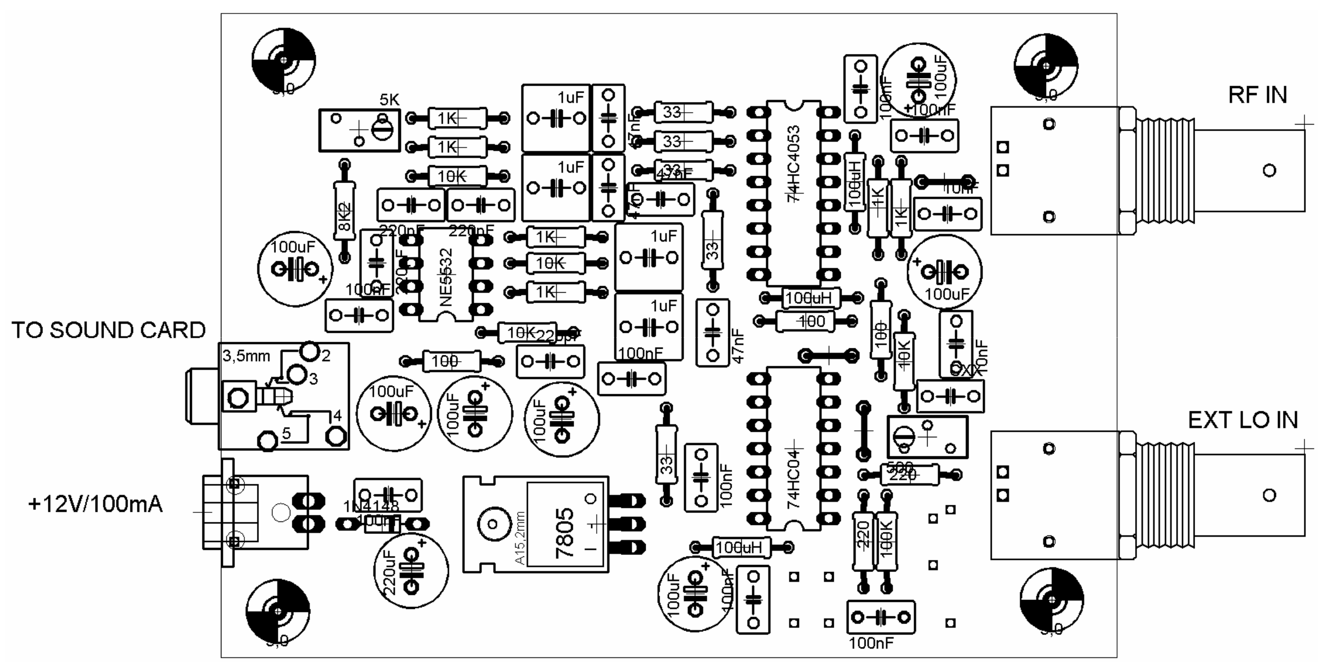




Phase shift simulation for both bands to notice in band phase change



Parts placement for DIL oscillator

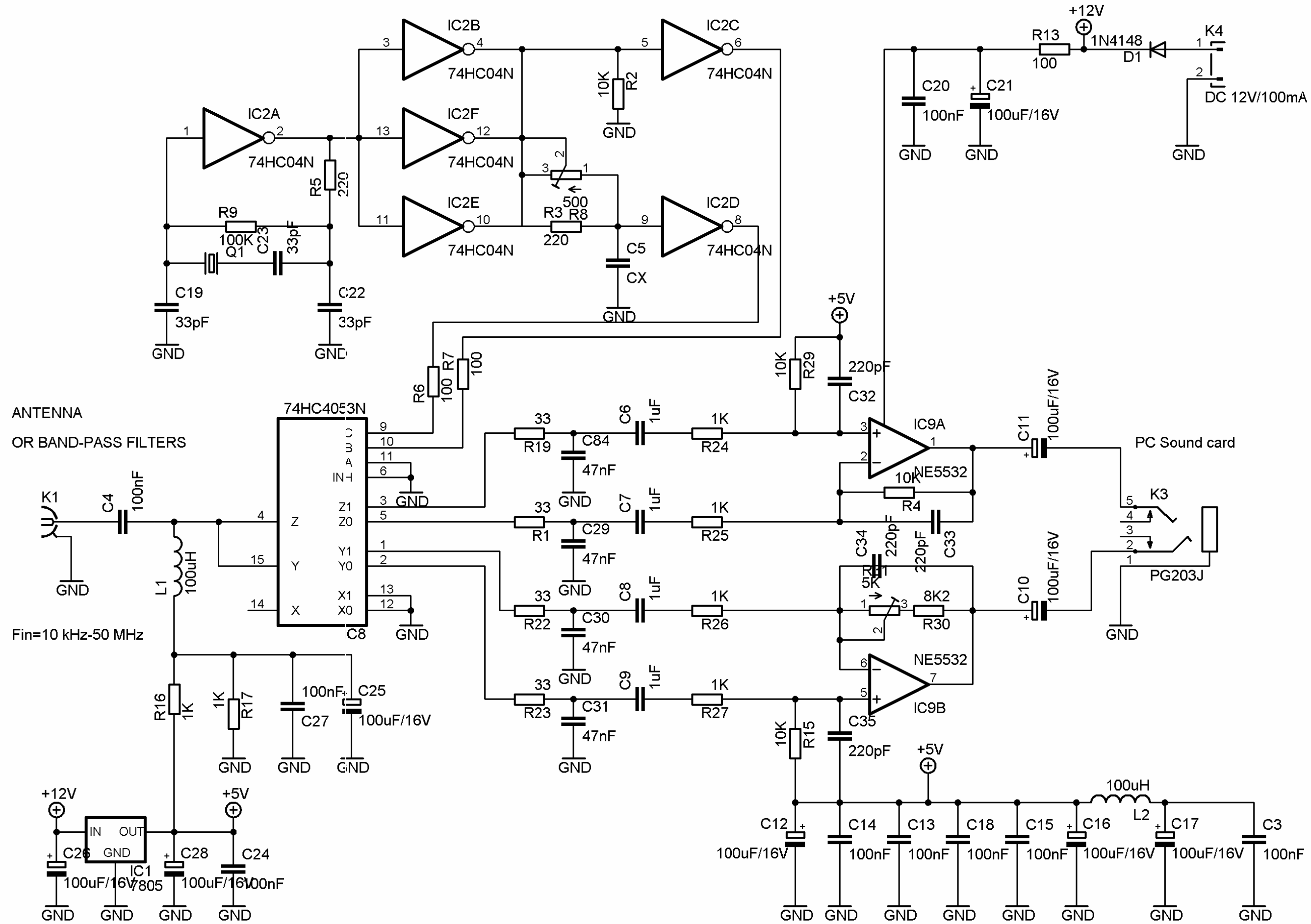


Parts placement for external oscillator

HF I/Q SDR Receiver DR2C - YU1LM/QRP

30 kHz-50 MHz

CX 1.8 MHz =2.2 nF CX 10.1 MHz =330 pF CX 24.9 MHz =150 pF
CX 3.5 MHz =1 nF CX 14 MHz =270 pF CX 28 MHz =100 pF
CX 7 MHz =560 pF CX 18.1 MHz =220 pF CX 50 MHz =68 pF

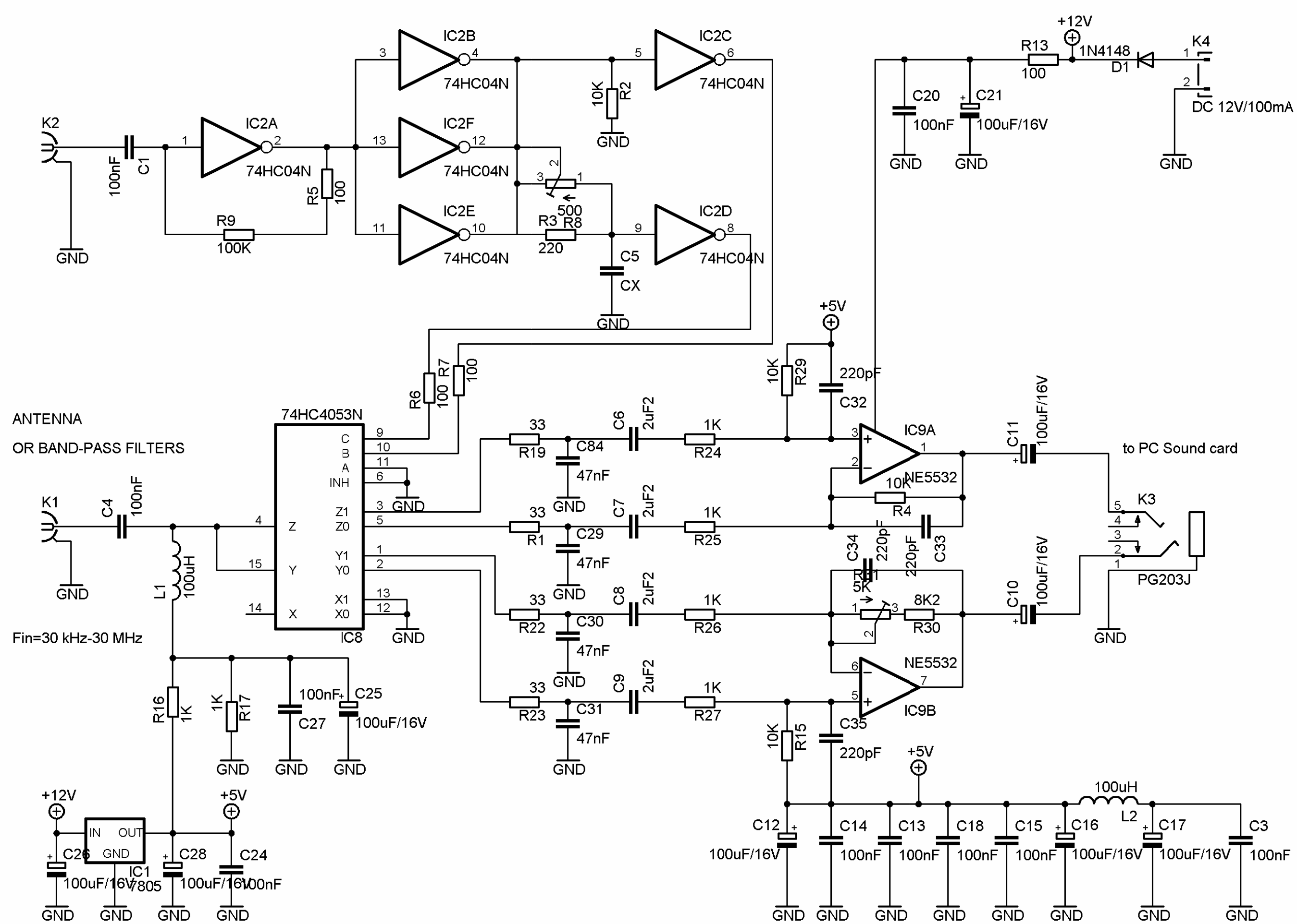


CONNECTION FOR INTERNAL OSCILLATOR

HF I/Q SDR Receiver DR2C - YU1LM/QRP

30 kHz-50 MHz

CX 1.8 MHz =2.2 nF CX 10.1 MHz =330 pF CX 24.9 MHz =150 pF
CX 3.5 MHz =1 nF CX 14 MHz =270 pF CX 28 MHz =100 pF
CX 7 MHz =560 pF CX 18.1 MHz =220 pF CX 50 MHz =68pF

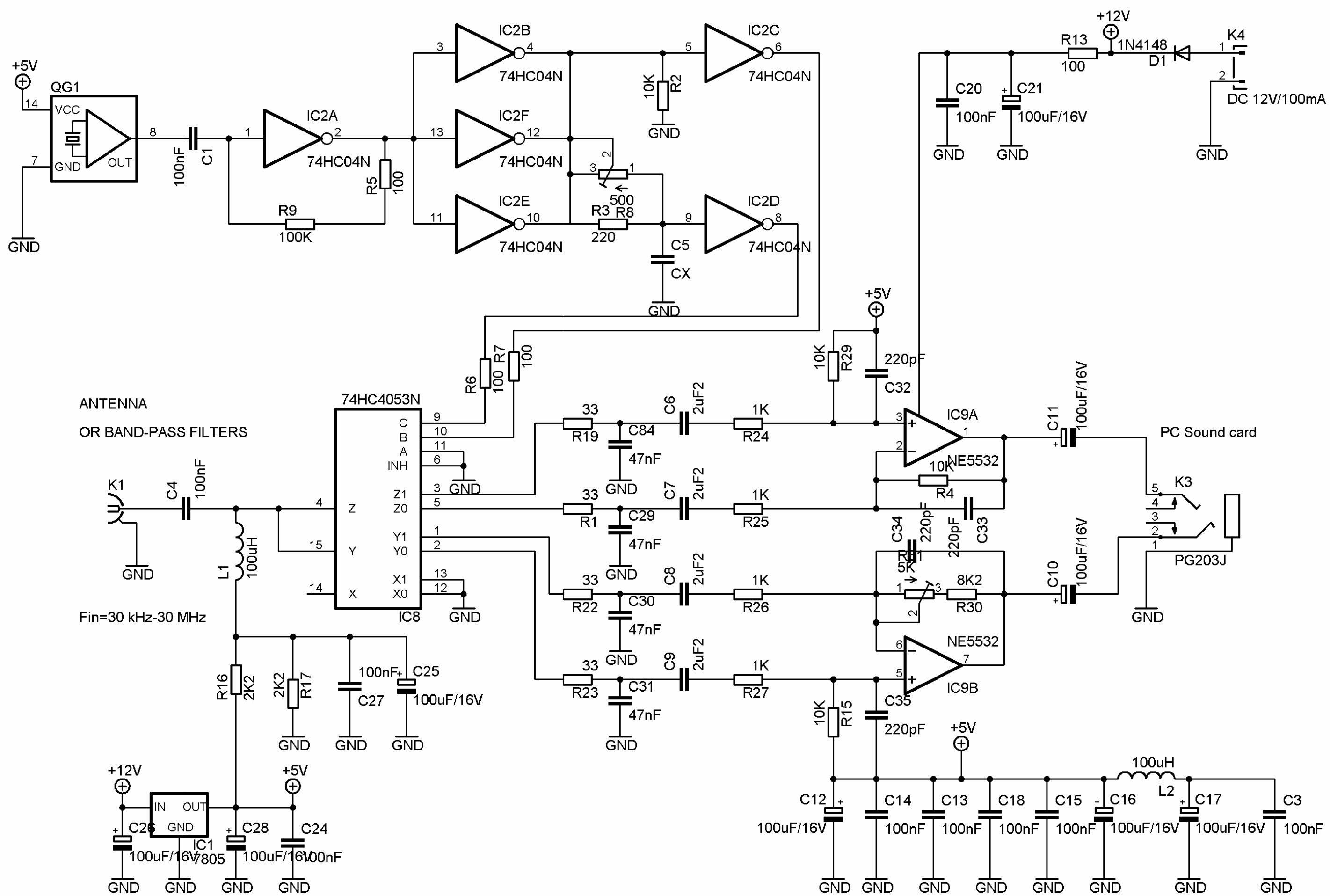


CONNECTION FOR EXTERNAL OSCILLATOR

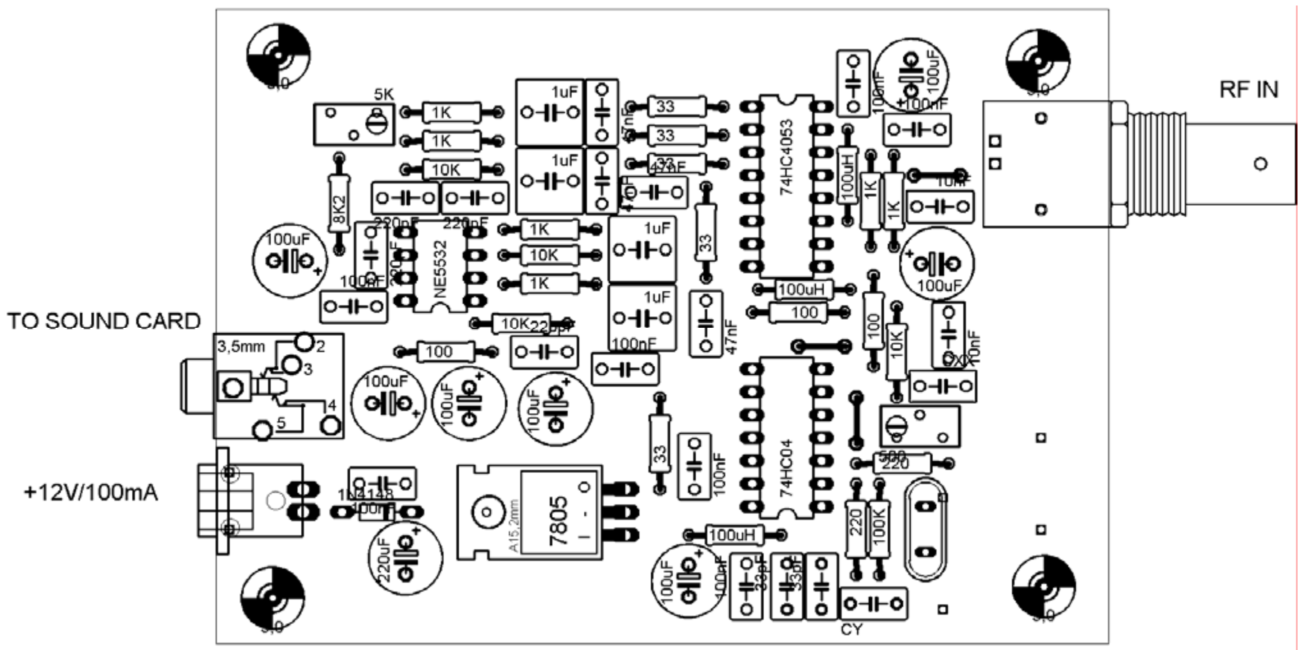
HF I/Q SDR Receiver DR2C - YU1LM/QRP

30 kHz-50 MHz

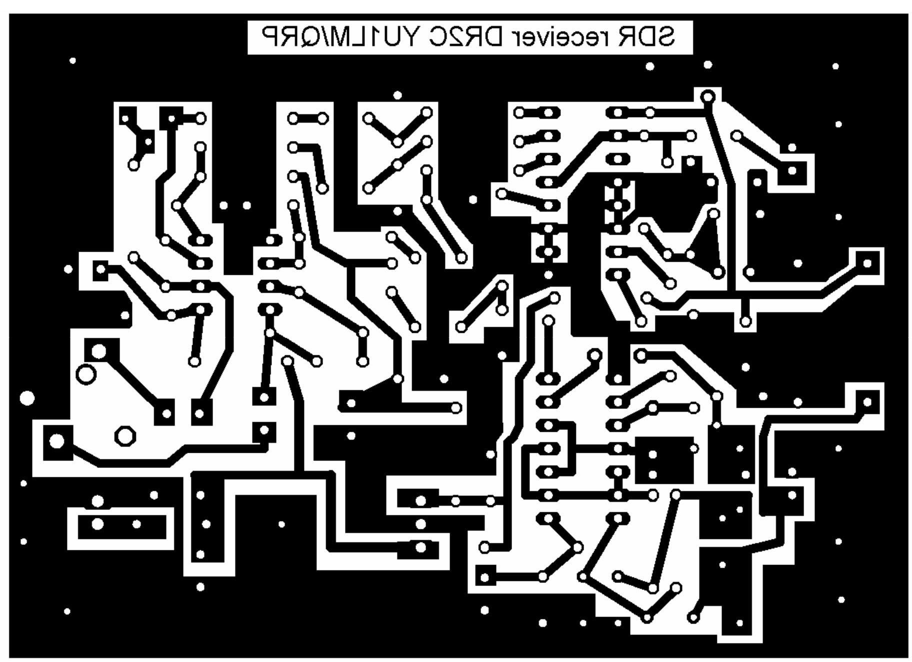
CX 1.8 MHz =2.2 nF CX 10.1 MHz =330 pF CX 24.9 MHz =150 pF
CX 3.5 MHz =1 nF CX 14 MHz =270 pF CX 28 MHz =100 pF
CX 7 MHz =560 pF CX 18.1 MHz =220 pF CX 50 MHz =68 pF



CONNECTION FOR DIL OSCILLATOR



Parts placement for internal oscillator, PCB size 97 x 70 mm



Measuring results I obtained with DR2C:

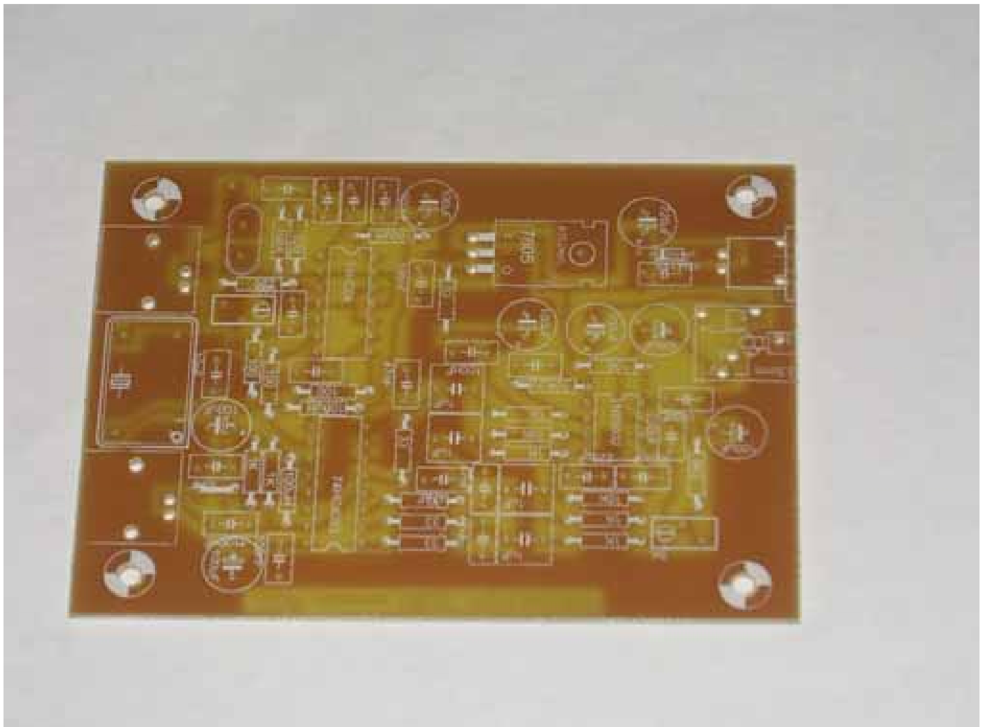
1. Receiving range from 30 kHz to 50 MHz (with Q unit oscillator it is limited to the 30 MHz)
2. IIP3 27-29 dBm it depends from setting and used programs (all done with 16 bit sound cards). Max measured IIP3 with only 6 dB AF gain was 33 dBm but with reduced sensitivity
3. MDS -102-105 dBm also with 16 bit SB card
4. Image rejection is possible adjust to 60-70 dB at single frequency.
5. Sensitivity is 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 70 dB. This sensitivity is more than enough for frequency near to 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain or putting some RF preamplifier in front of DR1 to lower F (noise figure) of receiver.
6. SFDR (Spurious free dynamic range) is 86-92 dB, this results are with signals spaced 5 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more. All measurements are done by use HP8662 signal generators and HP 70000 series spectrum analyzer.

Some excellent performances with 3 IC are not without other side:

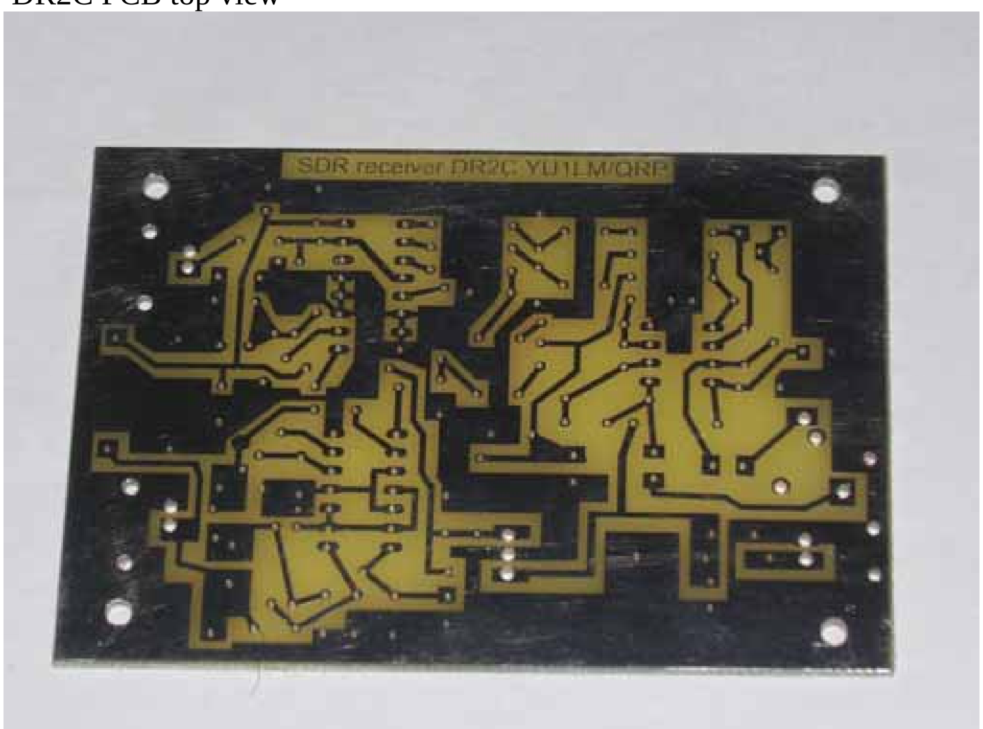
1. First and very big disadvantage is single band receiving
2. Image rejection is changing through receiving band.

DR2C adjustments are simple and done in two steps:

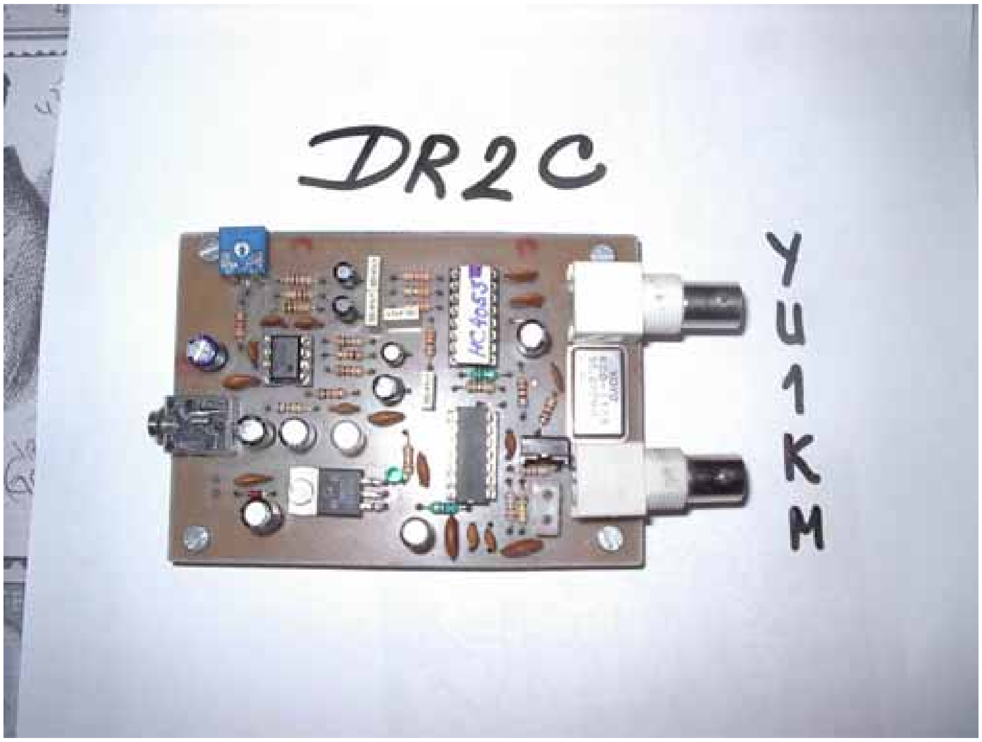
1. Adjust with DMM (digital multimeter) that is resistance in feedback potentiometer 5k +8K2 = 10 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal from signal generator to the input of DR2C in middle band and with 500 Ohm potentiometer adjust min unwanted image in used SDR program. Next step is with 5 Kohm potentiometer adjust new minimum of unwanted image signal. This procedure repeats few times to obtain optimum Additional image rejection adjust in SDR programs if this possibility exist (skew option in Alberto I2PHD programs).



DR2C PCB top view



DR2C PCB bottom view



First DR2C version built by Miki YU1KM

I wish you successful DR2C realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

GL in homebrew SDR 73/72 Tasa YU1LM/QRP   tasa@imtel-mikrotalasi.co.yu

References:

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3. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
4. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
5. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
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www.analog.com/en/prod/0,,770_843_AD9850,00.html

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http://www.labyrinth.net.au/~steve/freq/

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http://hem.passagen.se/communication/dds.html

7. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.99*

   www.qsl.net/i2phd Alberto I2PHDhttp://gpsdo.i2phd.com/
2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.weaksignals.com WINRAD*
4. *www.ciaoradio.com*
5. *www.m0kgk.co.uk/sdr*
6. *www.g8jcf.dyndns.org Peter G8JCF*
7. *http://www.nitehawk.com/sm5bsz Leif LINARD*
8. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
9. *dl6iak.ba-karlsruhe.de*

HF SDR (Software Defined Radio) S/H Sample and Hold Transceiver ADTRX1 from 30 KHz to 35 MHz - Make it Simple as Possible with Outstanding Performances Part 1

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

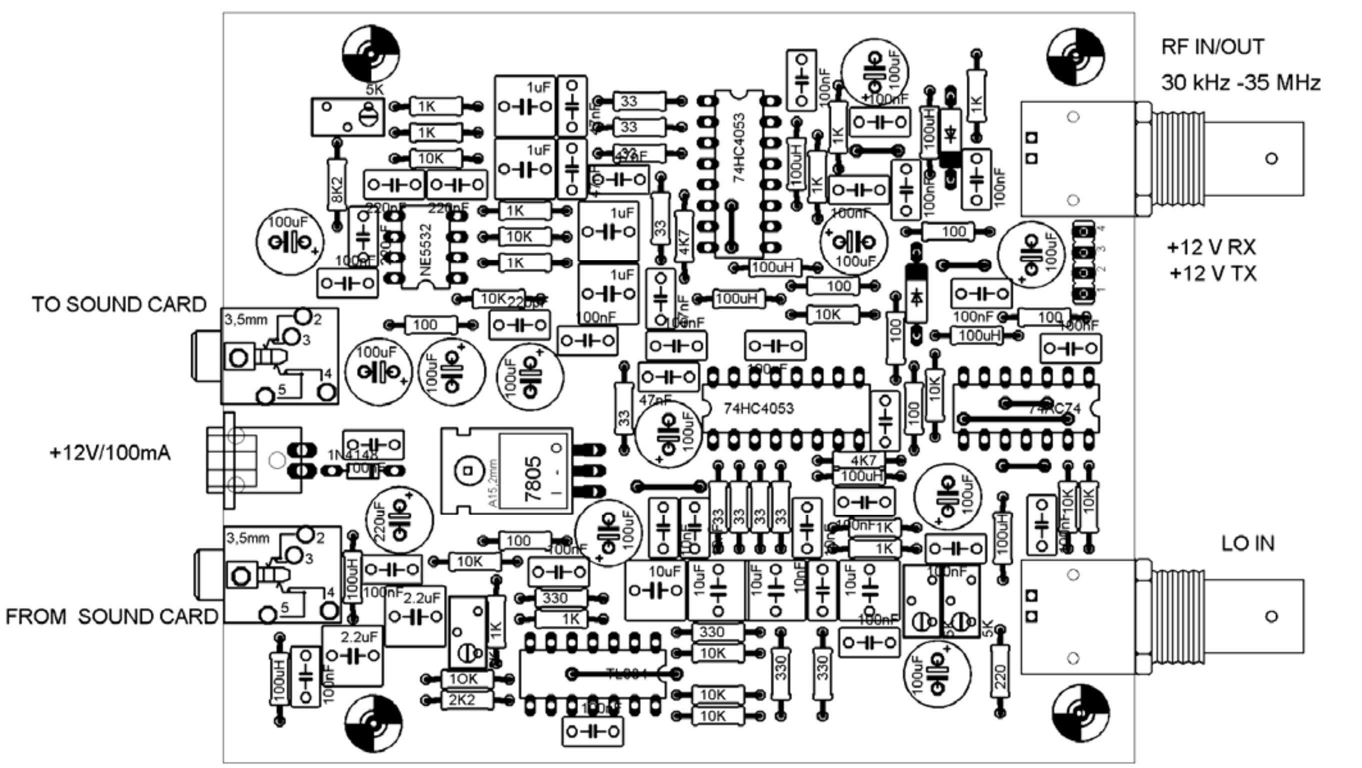
As I wrote before many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. and some built my transmission design DT1, DT2 and DT2A you can see some photos on my sites. I can notice that they are all mainly satisfied with results. Simple constructions with cheap classic size components working really very well. Also I find at INTERNET that some solutions from my receivers/transmitters are used in some new SDR projects.

I made my new SDR projects receivers DR2C, DR2B and DR3X with 74HC4053 IC. You can read articles related to these designs. My final goal is and it was to design SDR transceiver contest grade quality. I was waiting long time to obtain some freeware SB (sound blaster) software for SDR transceiver but still stay only hope. Some OMs like Alberto I2PHD made really fantastic job with his SDR receiving software thank you very much for them. But still we haven't free transmission programs for SSB which Alberto promised us some time ago but probably he couldn't find free time to do it... Because of that I made HF SDR transceiver called ADTRX1 (analog + digital). ADTRX1 is working to the 35 MHz and it is compilation of the results previously published design. Experimenting with DR2C receiver I noticed that 74HC4053 is very good IC little worse compared to the74 HC4066 but still with very well and respectively performances. Also RX/TX IC connections are much simpler than with 74HC4066. It is necessary only 2 (two) 90 DEG square signals for driving switches. Transmission part from DT2 and DT2A design I had been redesigned to the new IC 74HC4053.

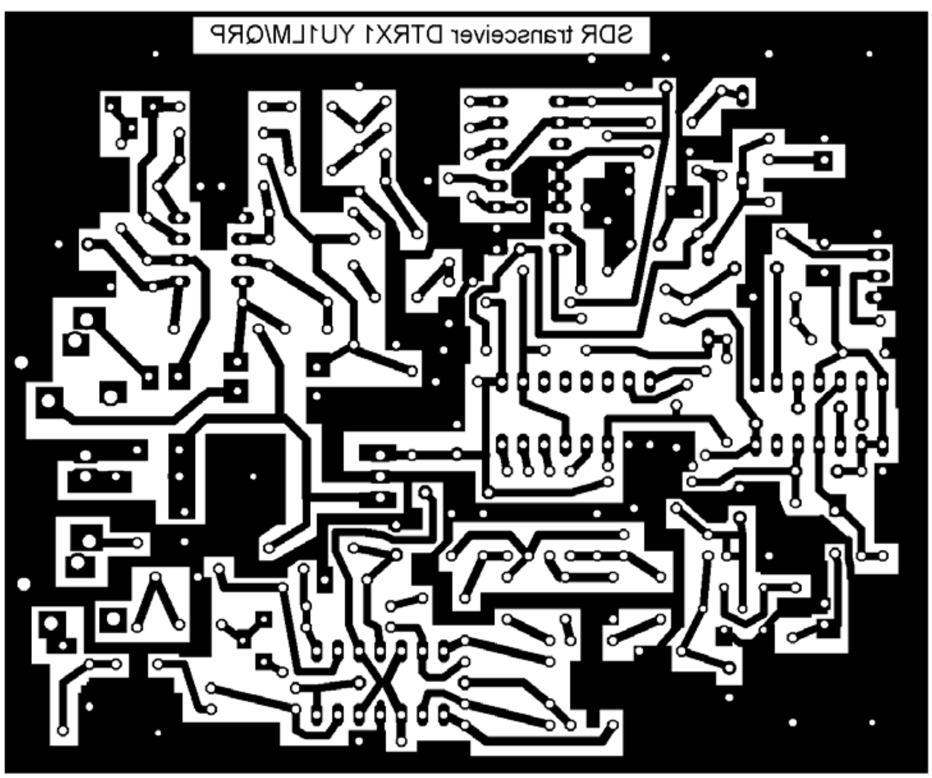
I made successfully CW and PSK transmission some details about that I explain later in part 2. For SSB or some other operation transceiver ADTRX1 is ready but operation is not easy possible in this moment reason leak of adequate SDR software program. In meanwhile I successive to perform SSB operation also see down diagram how I made it. It is little complicating for practical use but with adequate uC support instead PC use only. SSB operation is possible with change some parts on B2 board. I change bandwidth fmin/fmax for AF 90 deg all pass network to perform SSB operation.

I am using optimum technique to obtaining I/Q 90 DEG branches for driving CMOS switches with double D FF 74AC74 for max input frequency of 74HC4053.This solution dictate that we have 4 times higher LO (local oscillator) frequency than receiving/transmitting frequency is. Advantage of using 50/50 % duty cycle technique I explained in previously articles. Advantage is evident very much in my SDR transmission projects DT1, DT2 and DT2A and new SDR low power transceiver ADTRX1. In receivers this 50/50 % ratio is not so important like for the transmission. 50/50 % driving LO signals will increase max input frequencies with used ICs hardware realization and it will clear output spectrum.

Miss software support for SDR transmission I solved with 2 control board ADTRX1-B1 and ADTRX1-B2 connected in sandwich style like SDR1000 do. Here I shall describe main

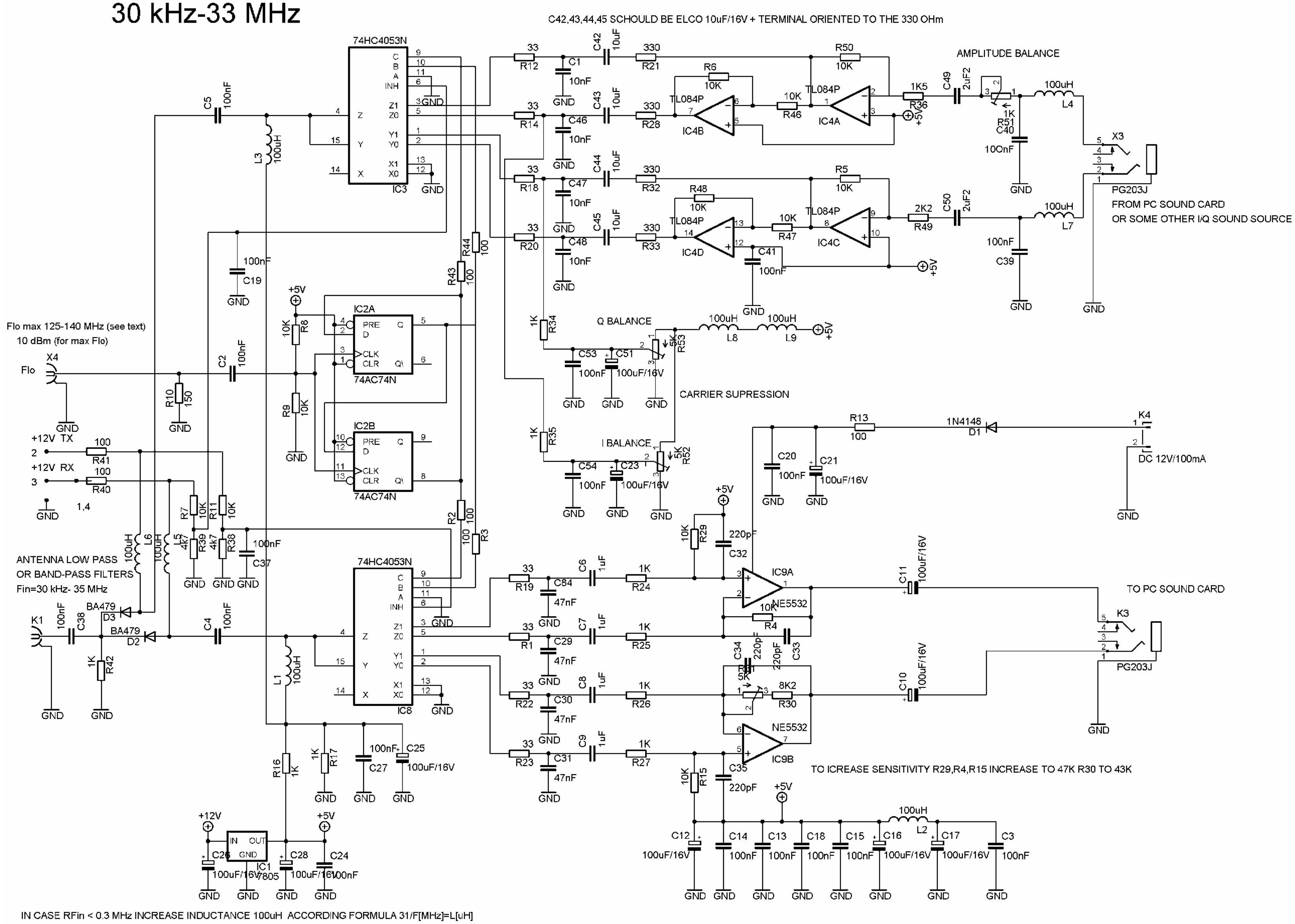


Single side PCB size is 110 x 92 mm



HF SDR Transceiver ADTRX1- YU1LM/QRP

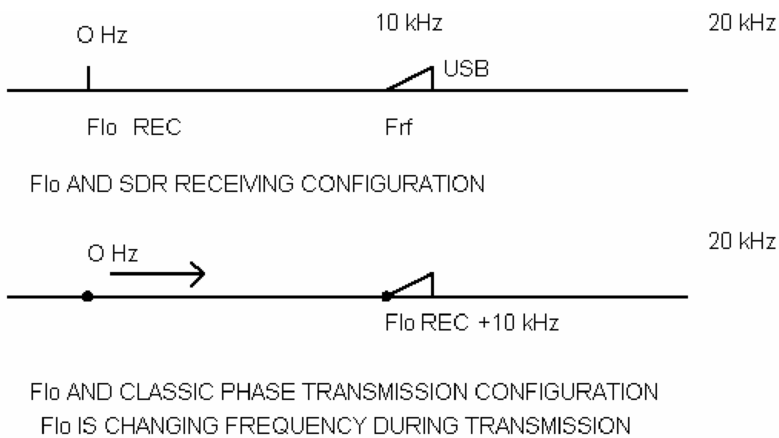
30 kHz-33 MHz



MAIN BOARD DTRX1

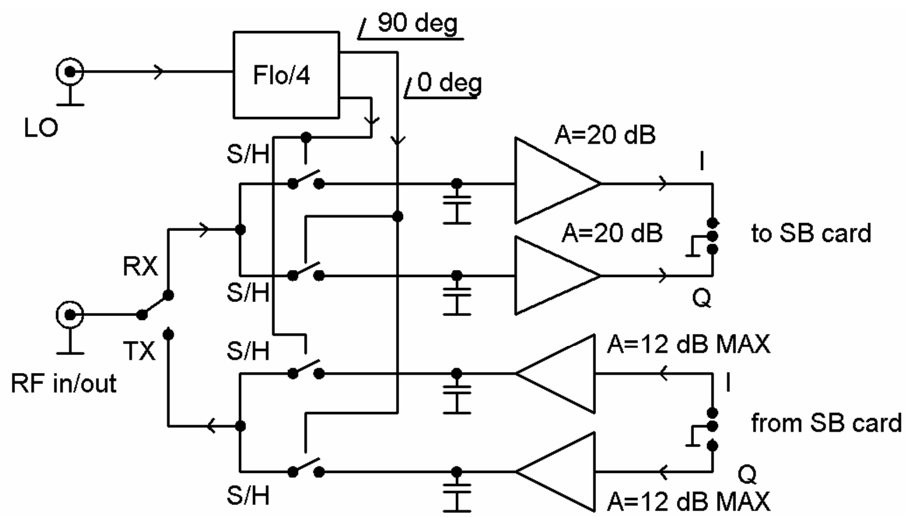
board and block diagram for control board B1 and B2. Schematics and PCBs for control boards I shall publish later in part 2. I shall not write too much about main board because main thing including results had been written in previously articles.

Here is only realization and how to use it... Operation is possible on all HF HAM bands up to the 35 MHz limited with 74AC74.Used 74AC74 frequency limit is 140 MHz with VCC=+6V. Instead PIN diodes BA479 it is possible some other PIN diodes or 1N4007 as substitute.

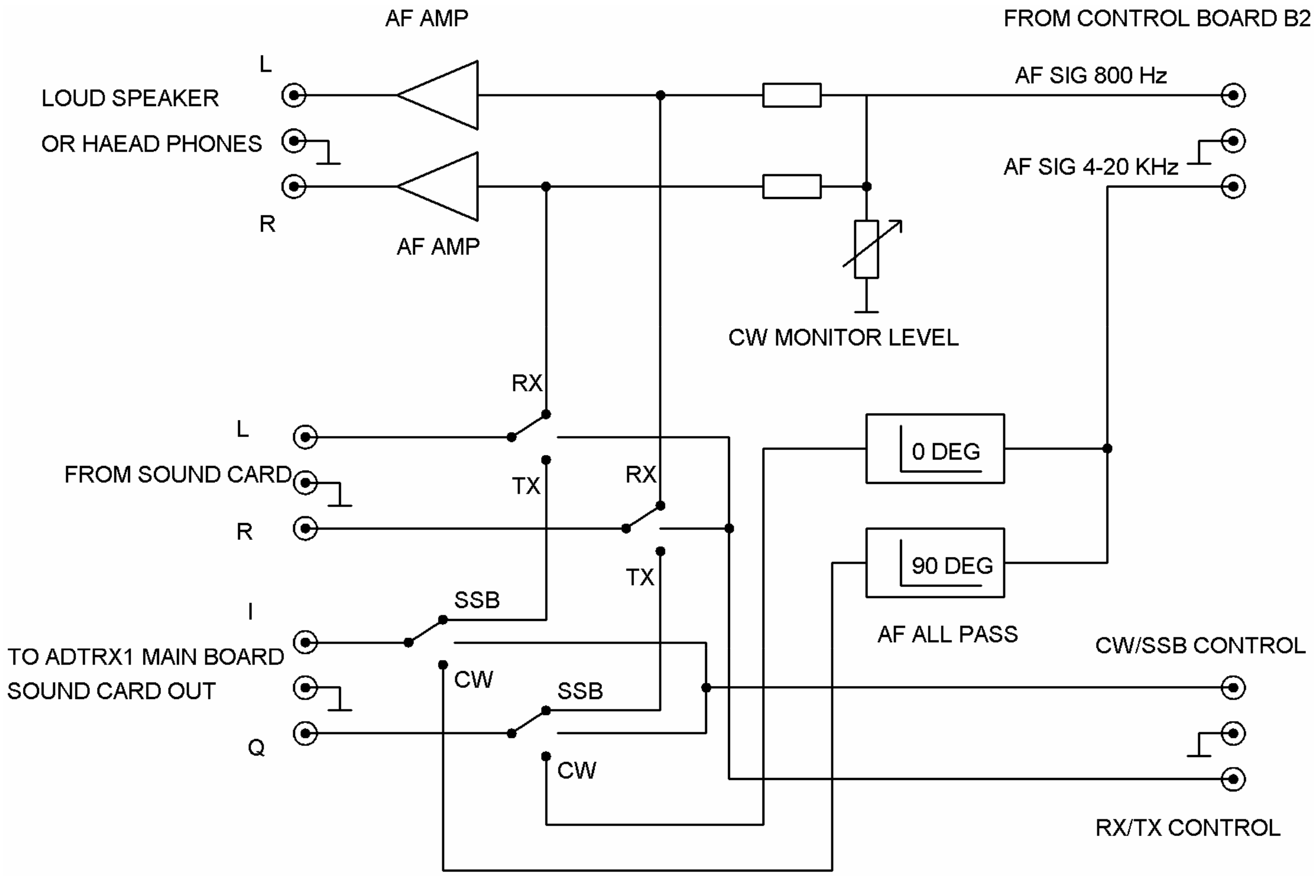


ADTRX1 CONFIGURATION FOR SSB TRANSMISSION

CONBINATION CLASSIC PHASE TRANSMISSION AND SDR RECEIVING



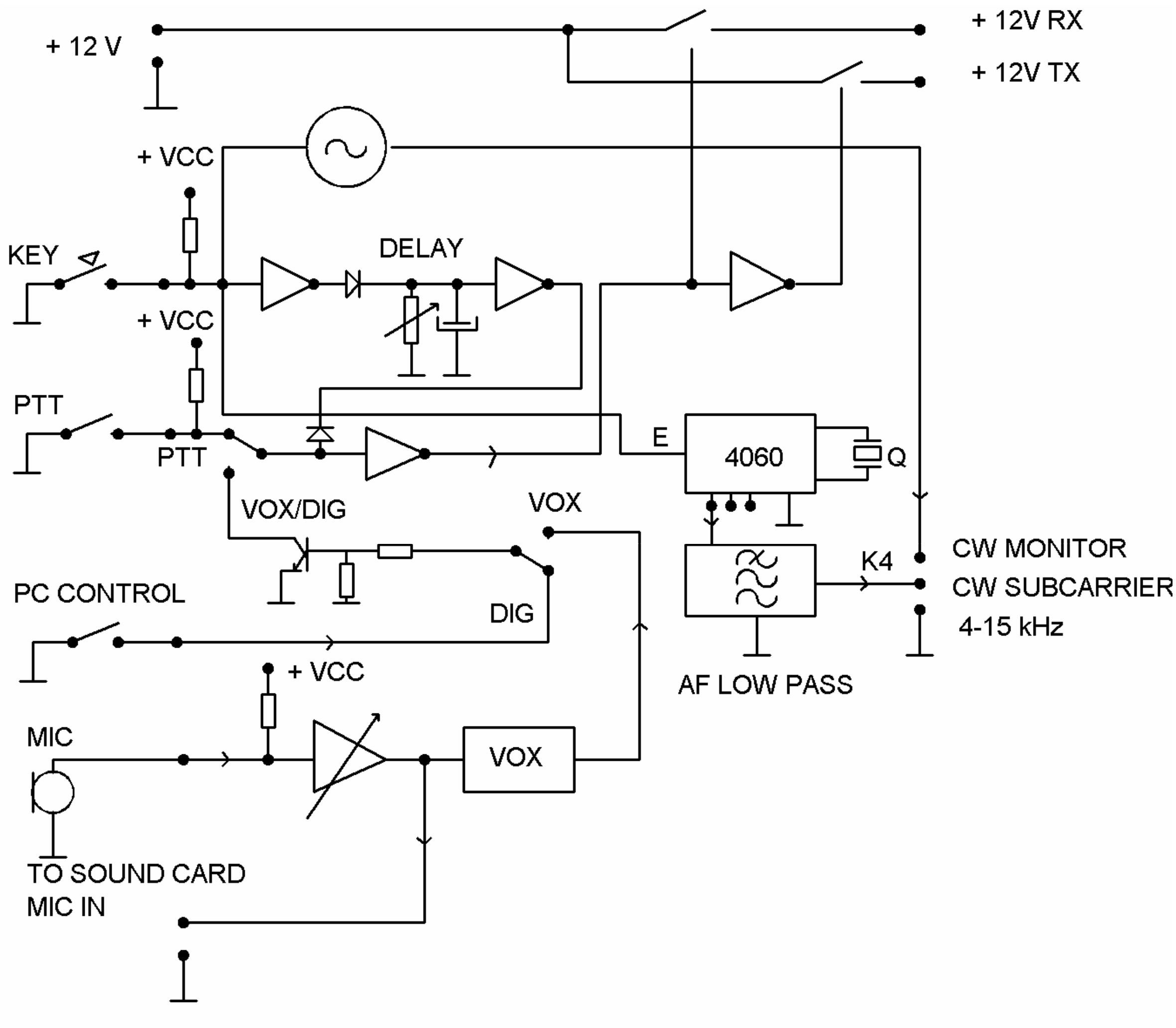
SIMPLIFIED SDR TRANSCEIVER ADTRX1 MAIN BOARD BLOCK DIAGRAM
YU1LM/QRP



BLOCK DIAGRAM - CONTROL BOARD B1 ADTRX1

In table is my proposals for high pass [HP] and low pass [LP] filters which will enable ADTRX1 receive /transmit on HAM radio bands. How to realized this filters are individual solution for every builder. I had been use, during testing ADTRX1, some my previously design and realization for HP and LP filters. Power amplifier is broad band HF amplifier and input power in it is in region from -4 to -6 dBm. On Internet you will find easy a lot of designs for this kind of amplifier.

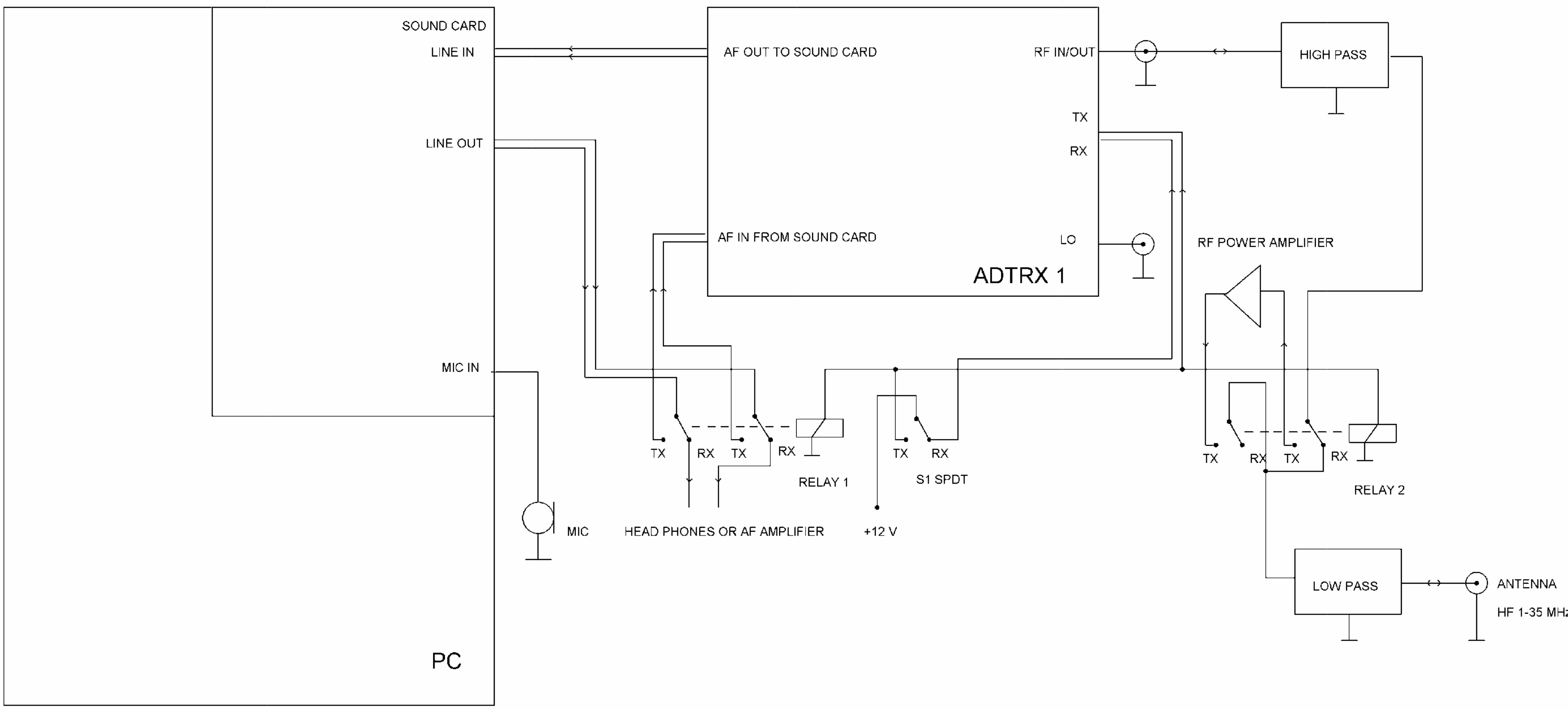
HAM Bands [MHz]	High Pass [MHz]	Low Pass [MHz]
1.8	1.5	2.5
3.5	3	4.7
7	6.5	7.5
10,14	9.7	16
18,21	17.5	24
24,28	24	31



CONTROL BOARD B2 BLOCK DIAGRAM

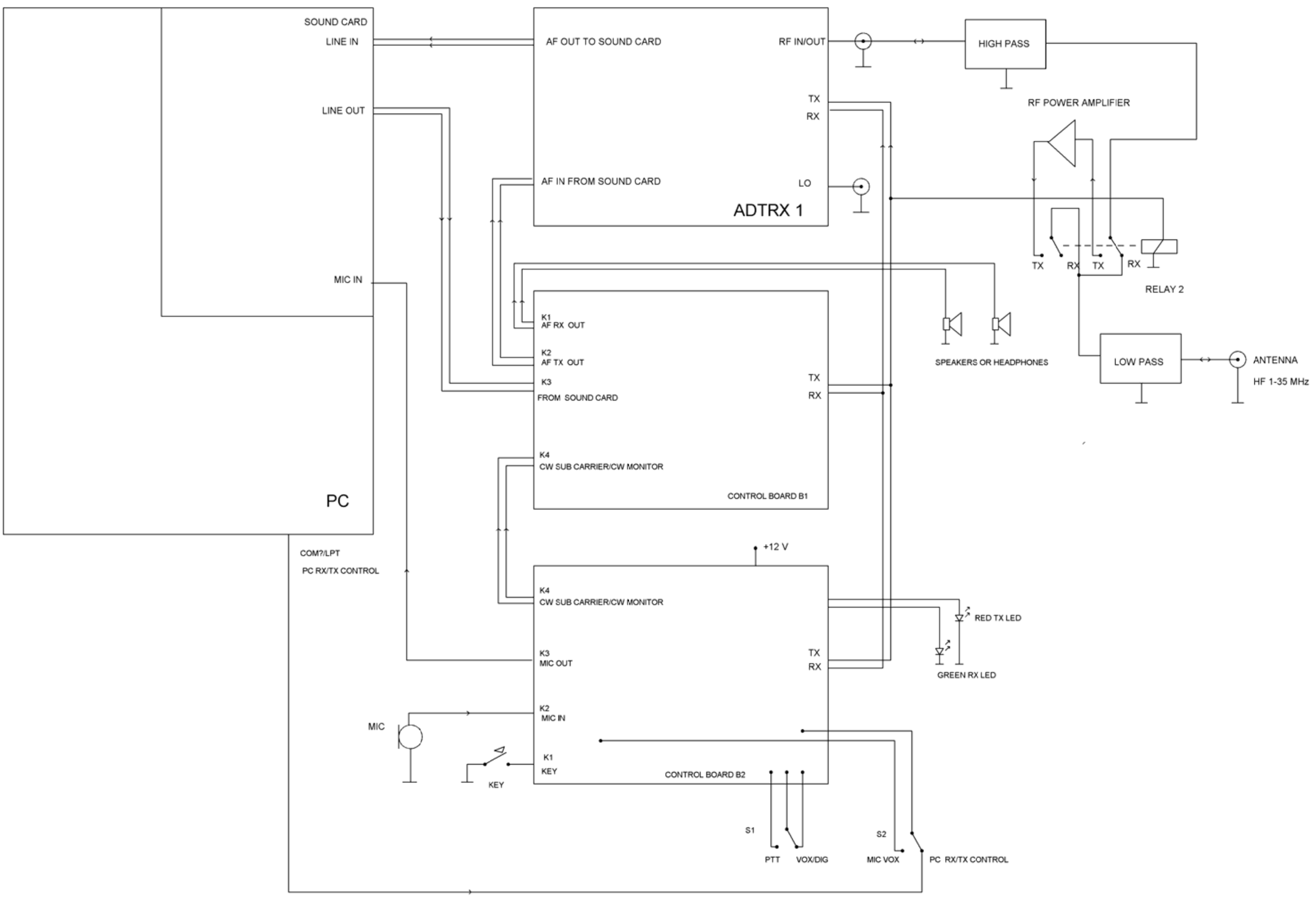
Down in text there are two basic ADTRX1 connections with and without additional control boards B1 and B2. There is possible also some new connection with ADTRX1 board control boards B1 and B2 and use 2 sound cards but this I shall describe in part 2 The simplest connection is with only ADTRX1 board and 2 relays and one SPDT switch. In this moment the problem is software support for this basic configuration. I hope that we shall have it in future soon maybe SDR transceiver software from Alberto I2PHD as he promised some times ago.

HF SDR S/H SAMPLE AND HOLD TRANSCEIVER ADTRX 1



BASIC ADTRX TRANSMIT/RECEIVE CONNECTION WITH PC SOUND CARD , 2 RELAYS AND 1 SPDT SWITCH

HF SDR S/H SAMPLE AND HOLD TRANSCEIVER ADTRX 1



BASIC ADTRX TRANSMIT/RECEIVE CONNECTION WITH PC SOUND CARD , CONTROL BOARD B1,B2 RELAY AND 2 SPDT SWITCH

I like CW very much and I like to take part in contests .For good CW operation it is very important to have very small delay in SDR processing between receiving and transmitting. Except good PC with high clock frequency and a lot of RAM very important is how signal in SB (sound blaster) DSP processing is done. Even an excellent SDR 1000 is not good as CW contest RIG. This I had been read on some forums devoted to SDR1000 some time ago. I can see that this demand for better CW operation is improving in every new version of FLEX software. I hadn't chance to test SDR 1000 personally to conclude this practically. Transmitting CW with SB card isn't easy task because it is necessary to decrease time delay between receiving / transmitting for good CW operation to really small values in msec region. To much time delay is making confusion in our brain we aren't learn to make CW keying with echo. Also our correspondent is starting transmission before we are starting receiving. To overcome this situation I made 2 control boards B1 and B2. With help boards B1 and B2 delay is long as it is for receiving process and delay time is in acceptable time border limits with good PC.

Measuring results which I made with HF S/H SDR transceiver ADTRX1

1. Receiving/transmitting range from 30 kHz to 35 MHz (with HP and LP filters limited to HAM bands 1.8……..28 MHz)
2. RX IIP3 27-29 dBm and it depends from setting and used programs (all with 16 bit sound cards).
3. RX MDS is -102-105 dBm also with 16 bit SB card Realtek AC97(with better SB card it is possible very easy to improve this value for 10 dB and more)
4. Image rejection is possible adjust to 35-60 dB 12 kHz from center frequency.
5. Sensitivity 3-5 uV for 10 dB S/N ratio, max S/N ratio I measured was 70 dB. This sensitivity is more than enough for frequency near to 20 MHz with adequate antenna system, for higher frequency it is recommend increasing AF gain (10 Kohms increase to max 100 Kohms R4,R29,R30 and R15) or putting some RF preamplifier in front of ADTRX1 to lower F (noise figure) of receiver.
6. RX SFDR (Spurious free dynamic range) is 86-92 dB, this results are with signals spaced 5 kHz and more. Results are not changing very much if we spaced two signals to classical 20 kHz or more. All measurements are done by use HP8662 signal generators and HP 70000 series spectrum analyzer.
7. In transmission carrier suppressions going from 30-60 dB , results depend from working frequency and adjustment
8. Unwanted side band suppression 30-50 dB
9. TX output power is in range from -5 to -2 dBm
10. Isolation between RX/TX is min 45 dB typical value is 55 dB

Some excellent performances with 5 IC are not without other side:

1. First and very big disadvantage is 4 times higher LO

2. RX image rejection and opposite TX sideband rejection are changing with receiving/transmitting band and results are for frequencies 10 kHz from central frequency
3. There is delay when we are going from transmission to receiving. Reason for that is delay in SB card and PC signal processing. With slower PC (lower clock) delay time is big even 1 sec close to make practically impossible transceiver operation...
4. For external LO it is necessary input level around 1 Vp-p min for safe operation (for lower LO drive operations are not sure especially for higher LO frequencies!!!

Lower power S/H SDR transceiver ADTRX1 adjustments are simple and done in few steps:

1. Receiver adjustment: Adjust with universal instruments DMM (digital multi meter) that is resistance in feedback potentiometer 5k +8K2 = 10 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal with signal generator to the input of DR3X and with 5 kOhm potentiometer adjust min unwanted image in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.
3. Transmission part adjustment is done in 2 iteration. Chose some high working frequency like 21 or 24 MHz. With help R52 and R53 adjust minimum carrier at working frequency monitoring on some receiver or better on spectrum analyzer. Next step is to adjust min of unwanted side band with help of R51. This procedure repeat once more for the best results and that is all

I wish you successful AFTRX1 realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

In part 2 I shall describe B1 and B2 PCB board and how to perform SSB, CW, and Digital (RTTY, PSK….) operation with used hardware. I shall describe how to adjust B1 and B2 boards for best results.

GL 73/72 Tasa YU1LM/QRP   tasa@imtel-mikrotalasi.co.yu

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7. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
6. *RF Design 6/1995*

Software LINK for SDR radio receiving and transmitting

1. *http://digilander.libero.it/i2phd/ SDRadio software ver 0.99*

   www.qsl.net/i2phd Alberto I2PHDhttp://gpsdo.i2phd.com/
2. *ik2czl@weaksignals.com <ik2czl@weaksignals.com>ik2czl@weaksignals.com <ik2czl@weaksignals.com>Vittorio*
3. *www.weaksignals.com WINRAD*
4. *www.ciaoradio.com*
5. *www.m0kgk.co.uk/sdr*
6. *www.g8jcf.dyndns.org Peter G8JCF*
7. *http://www.nitehawk.com/sm5bsz Leif LINARD*
8. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
9. *dl6iak.ba-karlsruhe.de*

HF SDR (Software Defined Radio) S/H Sample and Hold Transceiver ADTRX1 from 30 KHz to 35 MHz, correction, new version ADTRX1V1 and control boards B1 and B2 - Make it Simple as Possible with Outstanding Performances Part 2

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

When I succeeded to make operation with ADTRX1 board as I wrote in part 1 control and all other parts were on table or they were mainly "dead bug" construction with wires crossing all over the components and PCBs.. At that moment (April 2006) was problem software for transmission. I read a lot of articles and I made a lot of CAD simulations trying to find optimal solution in simplicity and a very good reproducibility with possibility to make CW/SSB and digital operation with built in hardware. In this moment November 2006 we have a quite different situation few software are ready for SDR transmission like Power SDR (KD5TFD version for Soft Rock KIT), Tom DL8SAQ's and Duncan M0KGK's see references down.

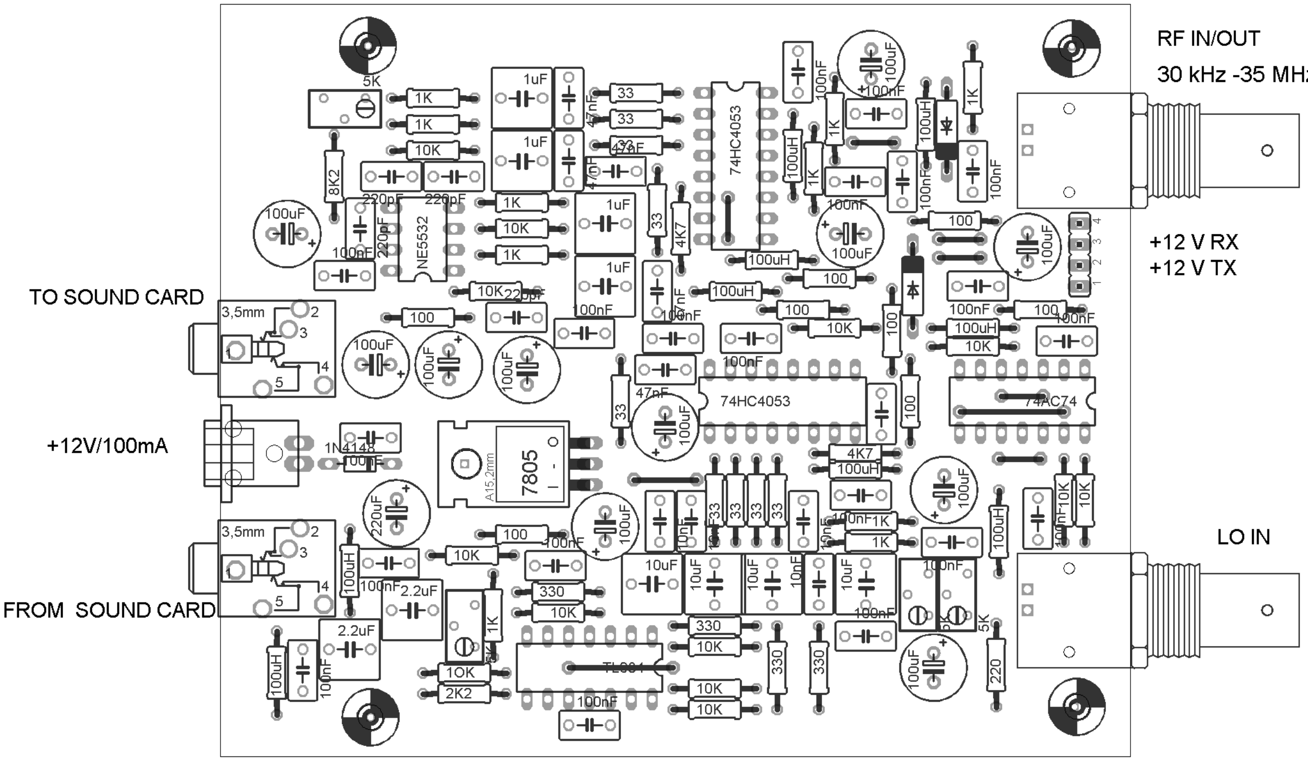
First let's start with errors. I made one fatal error at ADTRX1 PCB. Operation was not possible as I published because I had mixed transmit/receive control between 74HC4053 ICs. I have thank you to OM Wolfgang DK2CQ who first noticed this error. PCB which I had been realized was 85%-90 % of PCB published in article. Also in PCB I marked wrong value for R46 as 1K instead 10K . I have asked all who build ADTRX1 transceiver for apology for inconveniences and try to find what is wrong. Here down is a corrected PCB.

I made a new one version of ADTRX1-V1 PCB, with 2 AF gain position like it is done in the SDR receivers DR2 and DR2A, also. Practical operation with ADTRX1 made this solution as imperative demand for the frequencies over the 10 - 15 MHz to increase receiver sensitivity to sufficient level... In the schematics, there is nothing new to describe and all is the same as in early mentioned and published receivers. Changing gain between 2 position 20-46 dB is possible realized simple with the help of double SPDT toggle switch or fixed gain with jumper to lower or higher value. This decision is determined with a signal levels coming from the antenna. The small antennas lead to the high gain position and big vice versa.

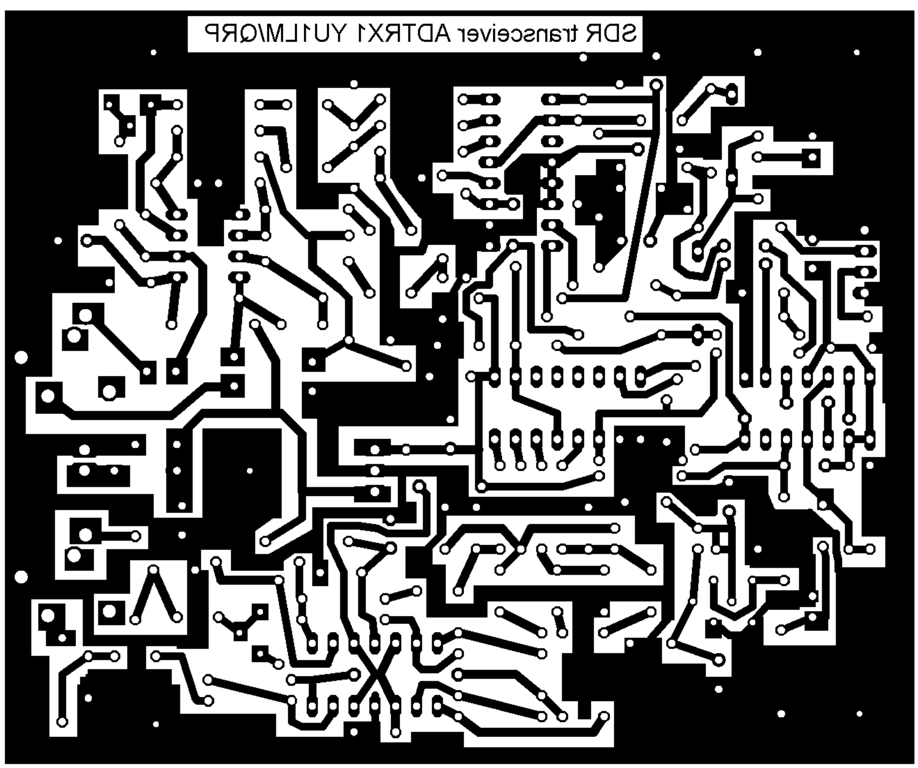
A receiving path in ADTRX1 is going always through the sound card (SB) and for transmission I describe here 3 ways how to perform them:

1. The first way is completely digitally with help of SB card or cards and PC only.
2. The second way is completely analog with built in hardware and it is classic direct phasing type transmitter with audio all pass phase shift network.
3. The third way is mixture, it is solution partly digital partly hardware with fixed audio IF.

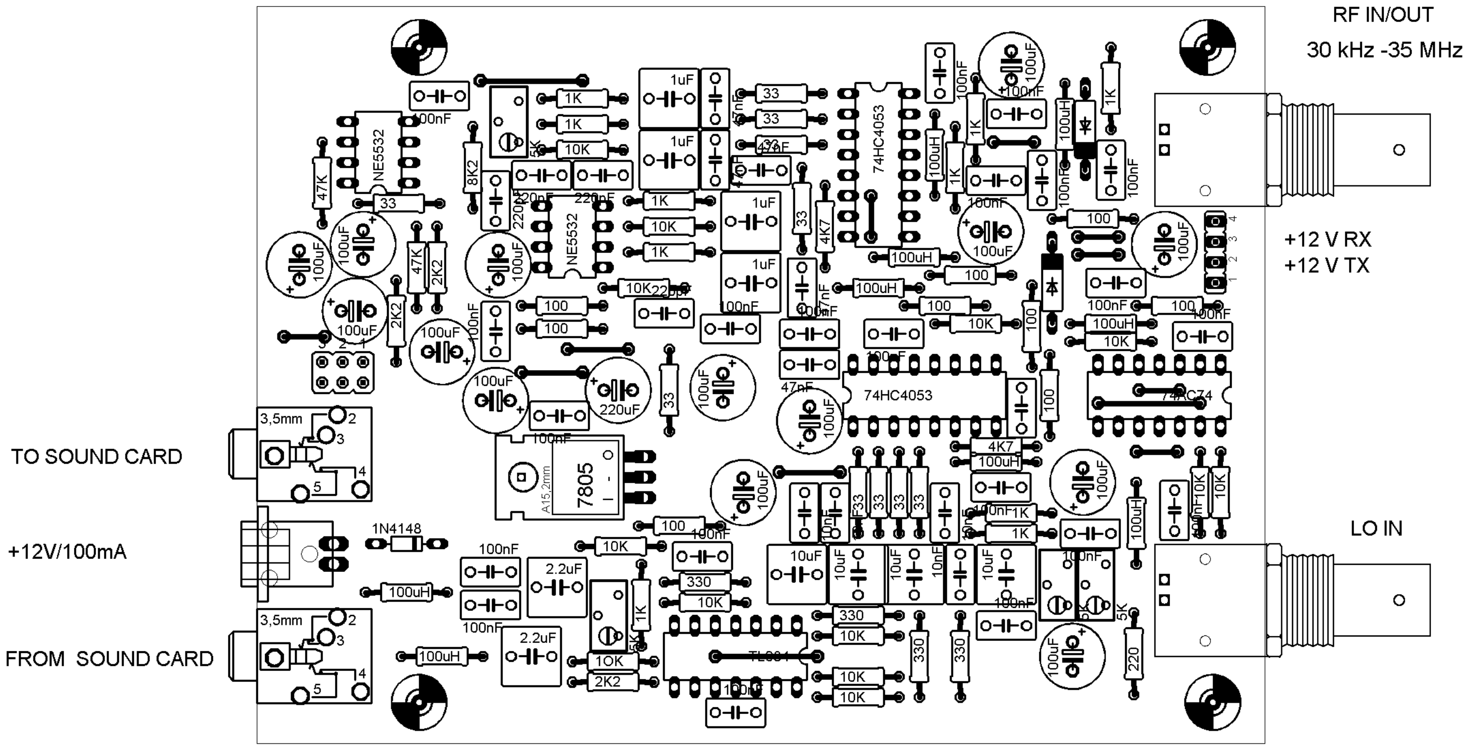
In the moment when I started design and experimenting with control boards, there were not freeware software for transmission. Now we have new software and situation is a quite different. Readers can and have to individually decide what to do and how like to do transmission. All solutions have some positive and negative aspects and decision depend on what you like to realize, speed in CW operation or simplicity. Down is corrected PCB and part placement for ADTRX1.



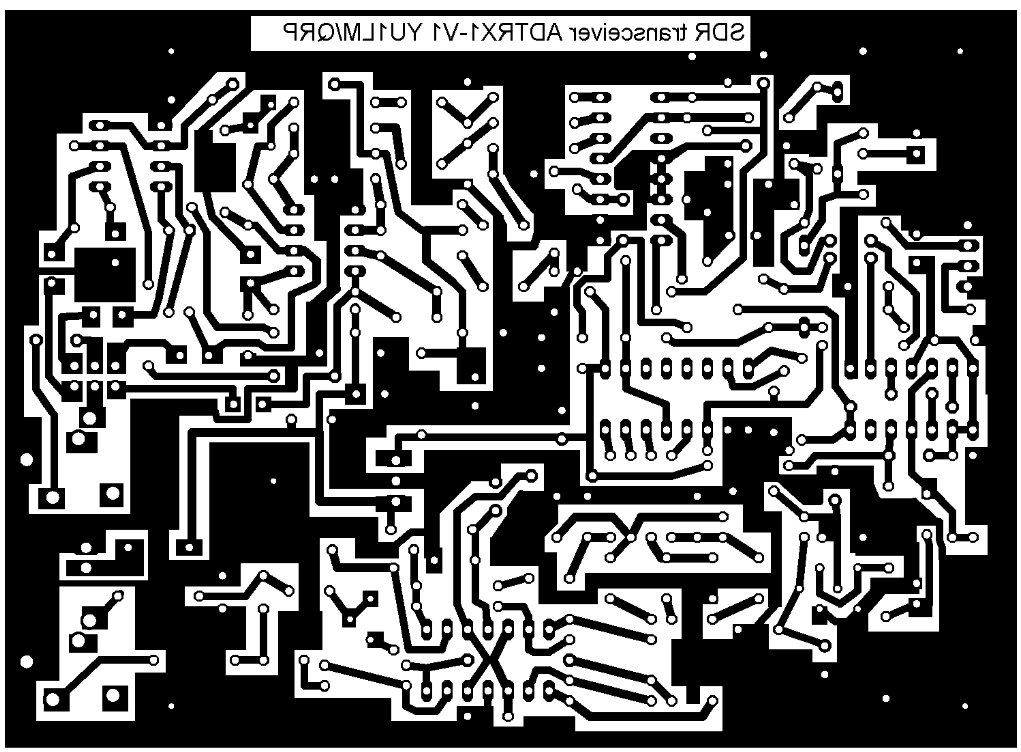
Single side PCB size is 110 x 92 mm



New version ADTRX1-V1 with 2 AF gain position

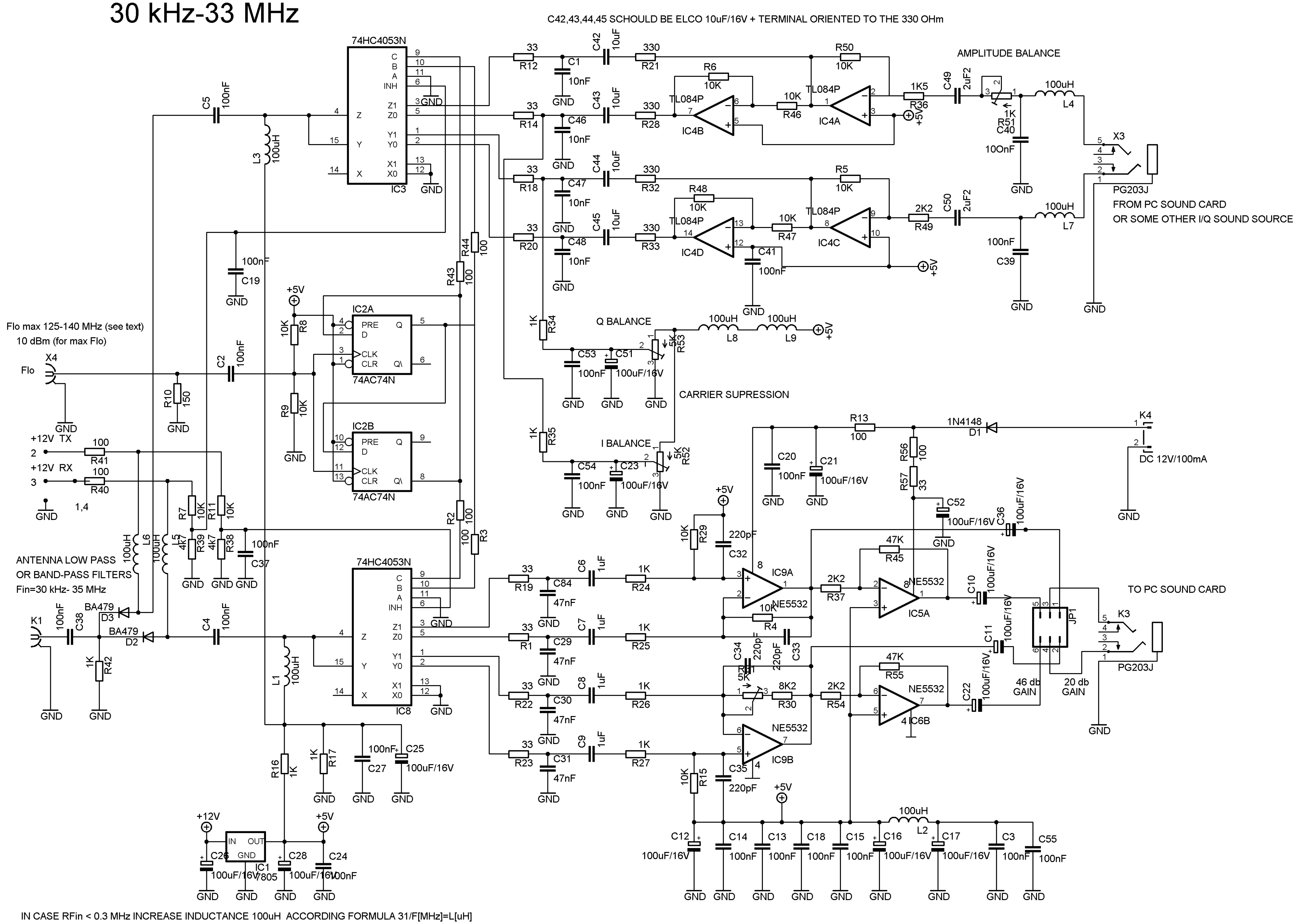


Single side PCB dimension 125 x 92 mm



HF SDR Transceiver ADTRX1V1- YU1LM/QRP

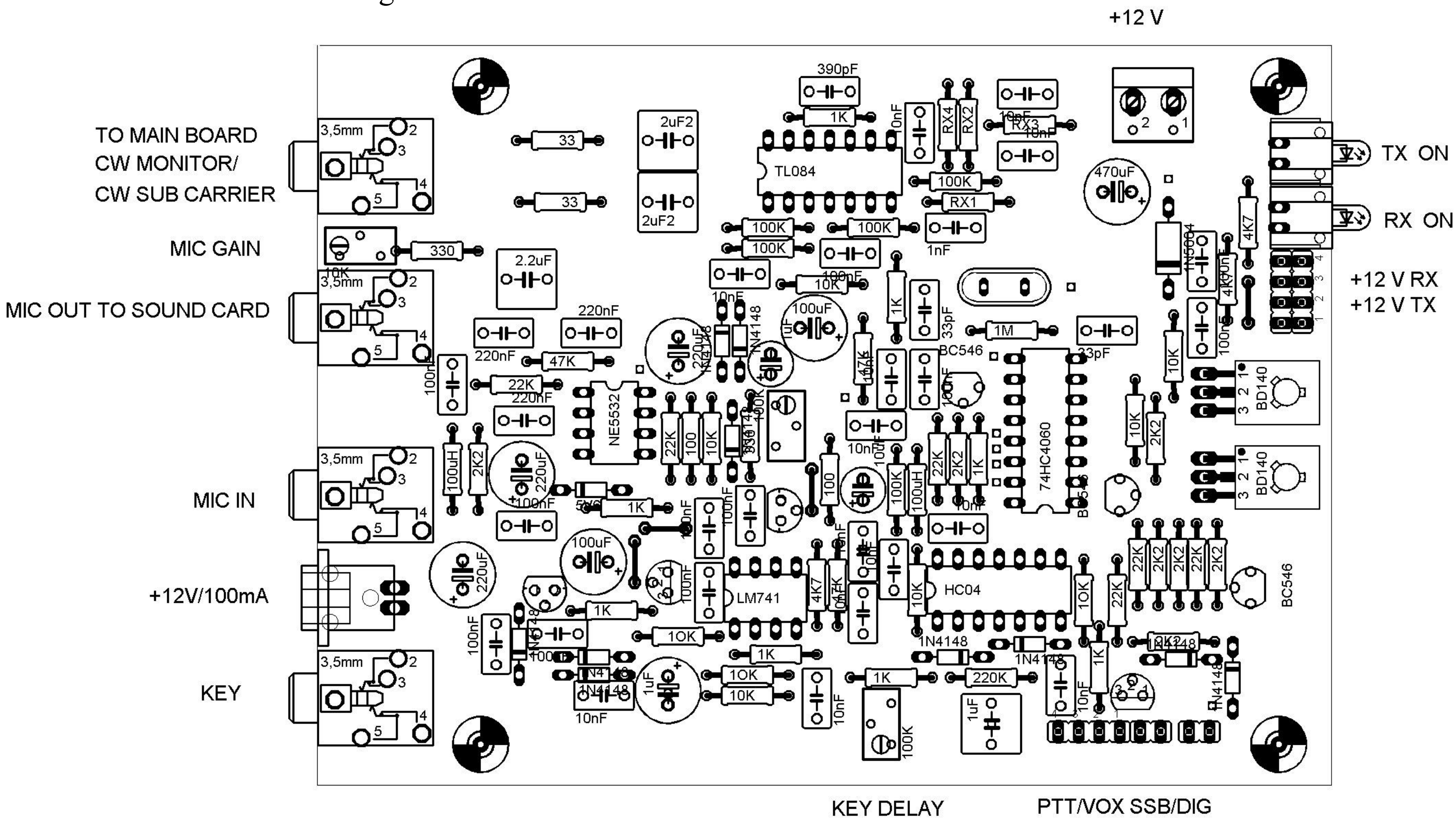
30 kHz-33 MHz

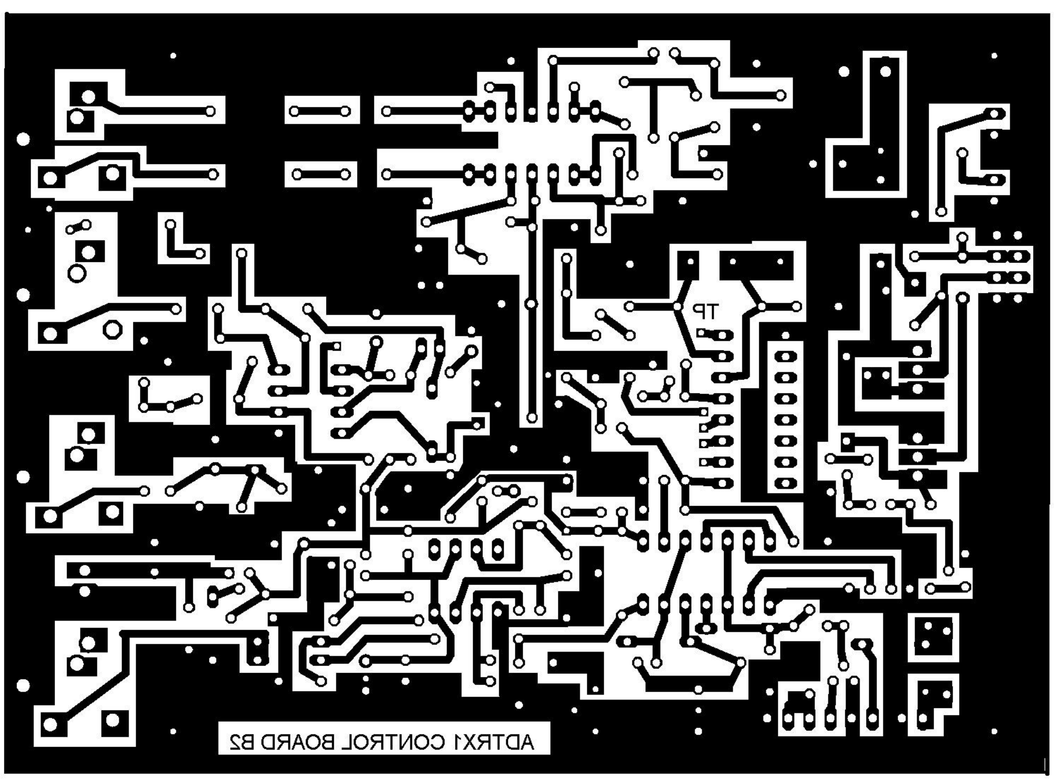


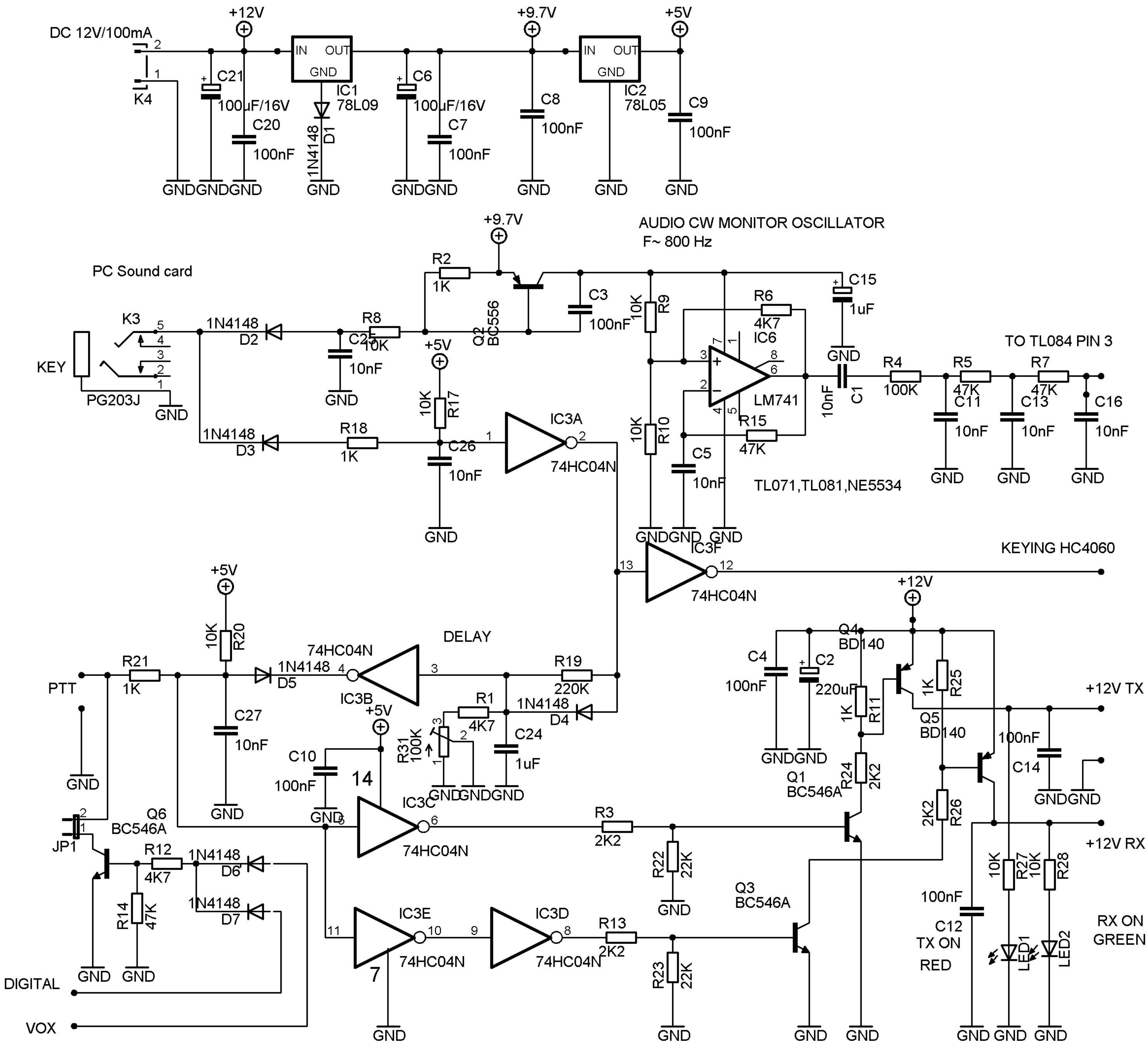
MAIN BOARD ADTRX1-V1

1. First way – ADTRX1 transmission is with a help of SB card and PC only. This way is optimum between simplicity and obtained performances. This is also the simple as possible way to make SDR transmission. For this way it is necessary PCBs with next order in sandwich: control board B1, ADTRX1-V1 board and B2 control board. B2 board is a combination published designs many times in different magazines and ARRL handbooks too. First we have variable MIC microphone gain amplifier for electrets microphone (you can chose cheep computer microphone) and VOX system for SSB or digital operation. B1 board system is in this moment without ANTI-VOX operation and it is not 100 % problem if we are using head phones. VOX system is realized at the same way as it is done in SDR1000 transceiver. With potentiometer is possible adjust VOX sensitivity. CW monitor is the same like it is in famous W7EL optimized QRP transceiver published in QST and many times reprinted in ARRL Handbooks. W7EL design was published first time more than 20 years ago. I used this solution few times in my designs and I like this simple solution very much. The output from the oscillator is square signal. To obtain much pleasant sound for my ear this signal is passing by through LP (low pass) realized with OP AMP TL084 CW shaping in keying is optimized with R-C combination to lower keying clicks. PTT/VOX and CW control and adjustable delay is realized with HC04 invertors. The control signals + 12V for receiving /transmission are obtaining with 2 PNP TO220 transistors BD140. VOX control is possible with PC DTR …or some other controls signals and selection with jumper is possible also. At the same PCB we have place for montage option for 2 and 3 way of transmission it is digital oscillator with 4060 IC and binary divider inside IC. The XTAL frequency isn’t critical. It is important that after dividing we are obtaining audio frequency between 3-20 kHz as IF frequency for transmission and same for receiving we are choosing in SDR software. It is choosing fixed audio SDR IF. Output signal after LP (low pass) with TL084 is a sinusoidal signal with the all harmonics content lower than 55-60 dBc.

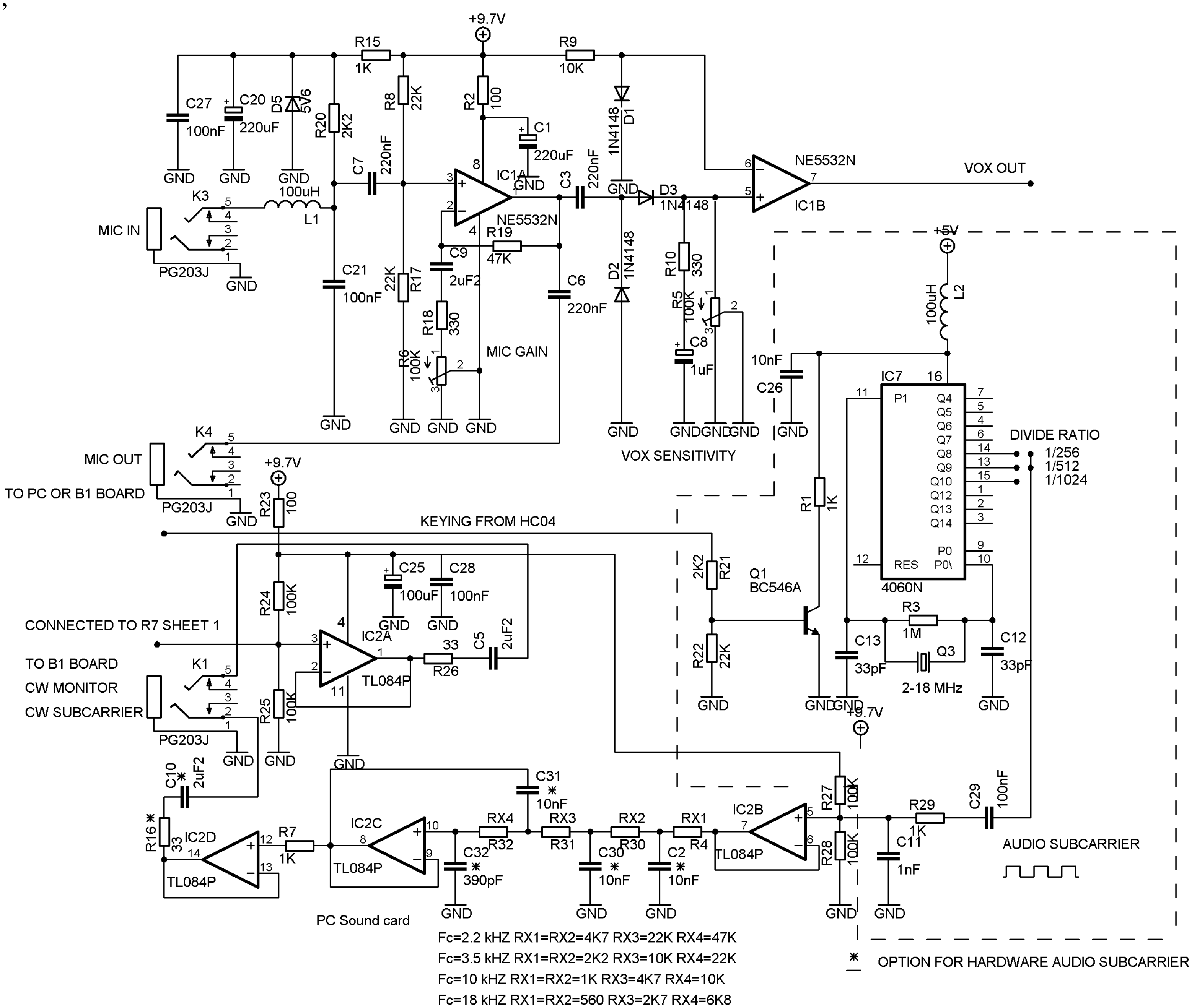
B2 Control board single side PCB dimension 125 x 92 mm





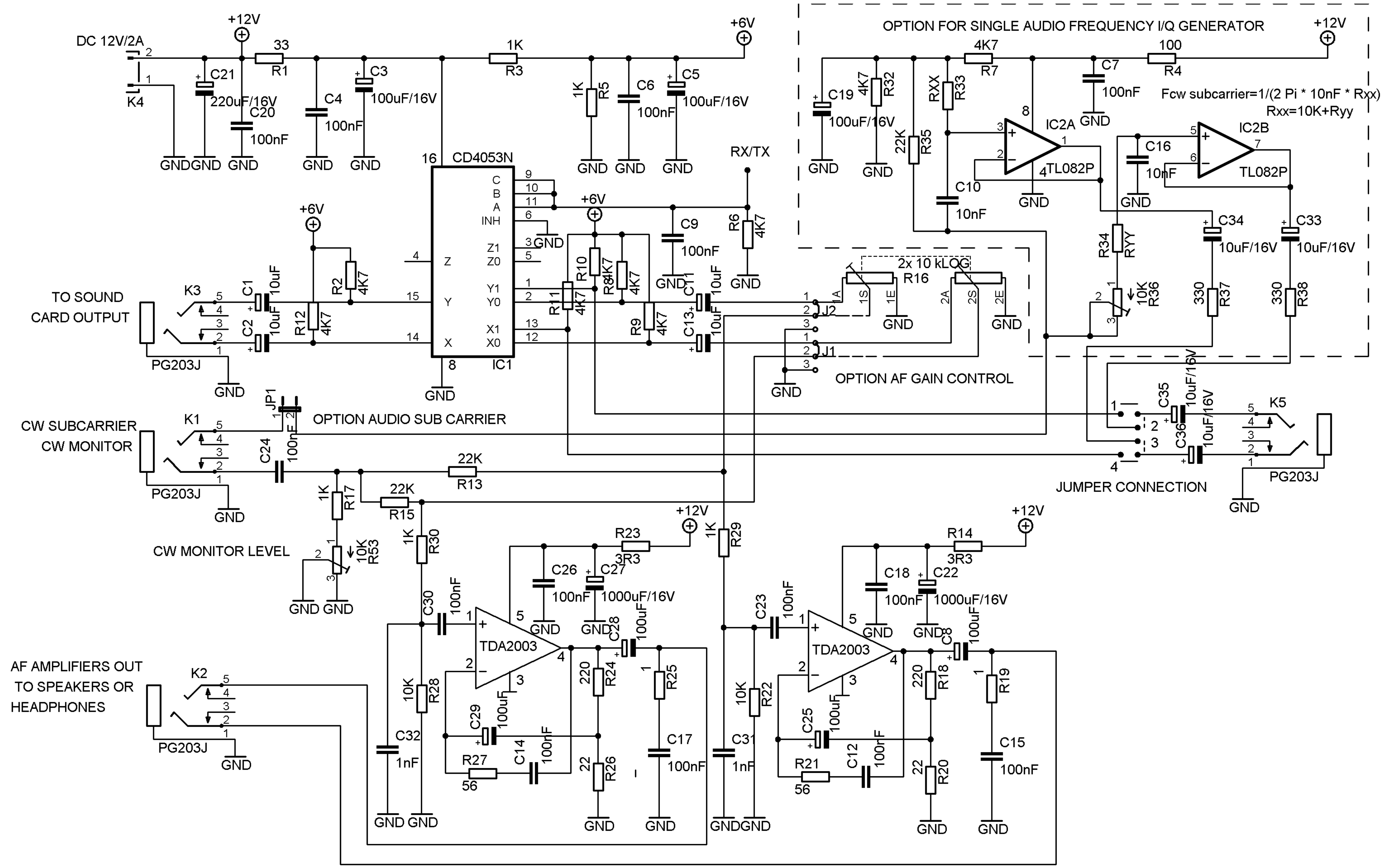


CONTROL BOARD B2 SHEET1



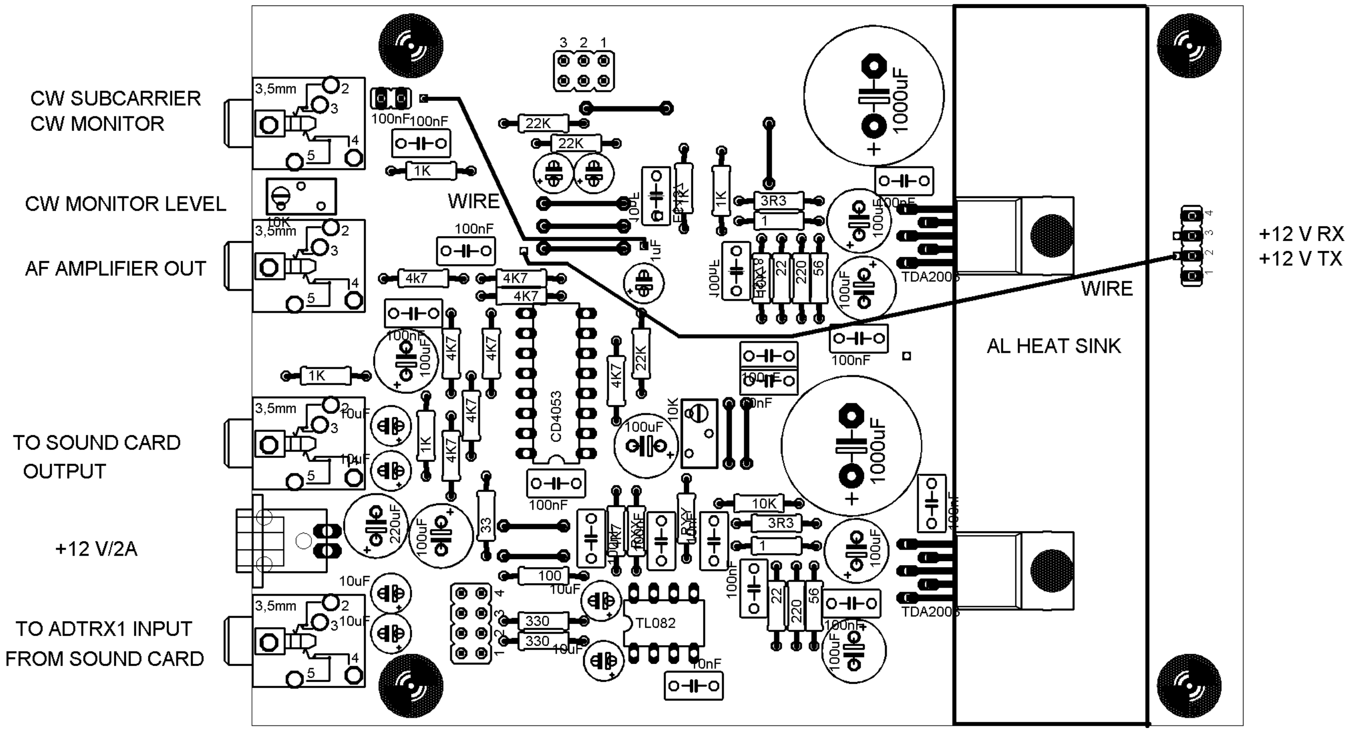
B2 BOARD SHEET 2

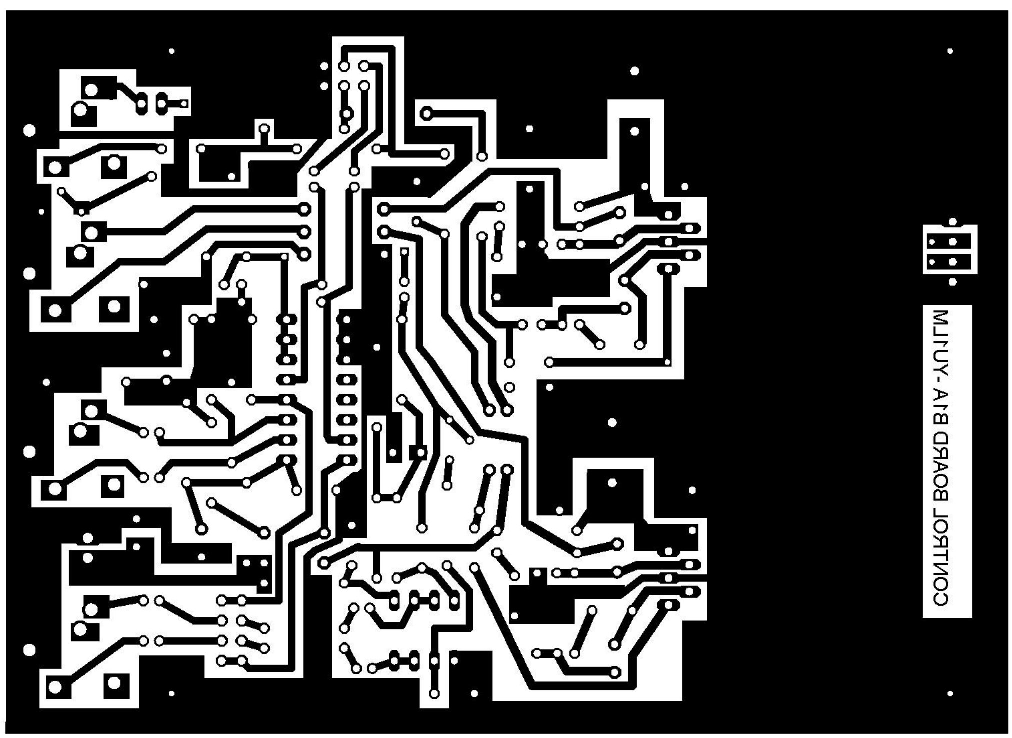
A control board B1 is commutating circuit during transmission/receiving change also on B1 PCB is 2 channel audio power amplifiers 2 x 2-3 W realized with TDA2003 ICs. This circuit and ICs are well known between radio designers as very good high performances solution for audio power output. In AF amplifiers we have possibility to reduce noise bandwidth with in serial 56 Ohms and 100nF connection it is important to notice that for the third way of SDR transmission we have a fixed audio IF. At the same PCB is CW audio level control and audio phase shift for fixed audio IF, for third way of transmission.



CONTROL BOARD B1A - YU1LM/QRP

I am using in commutating circuit for transmission/receiving path at +12V IC CD4053 or HEF4053 ICs. Most 74HC4053 will be destroyed with this VCC because it is over their voltage limits (typical limit values 7-10 V).

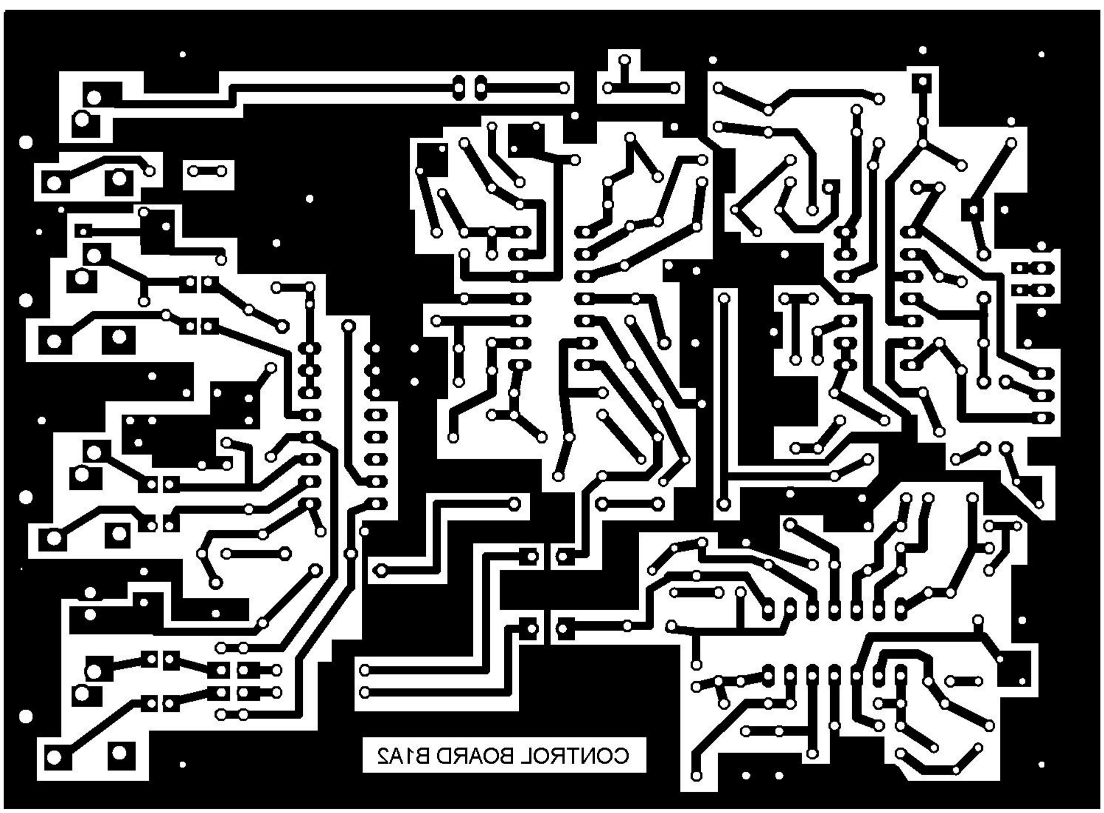




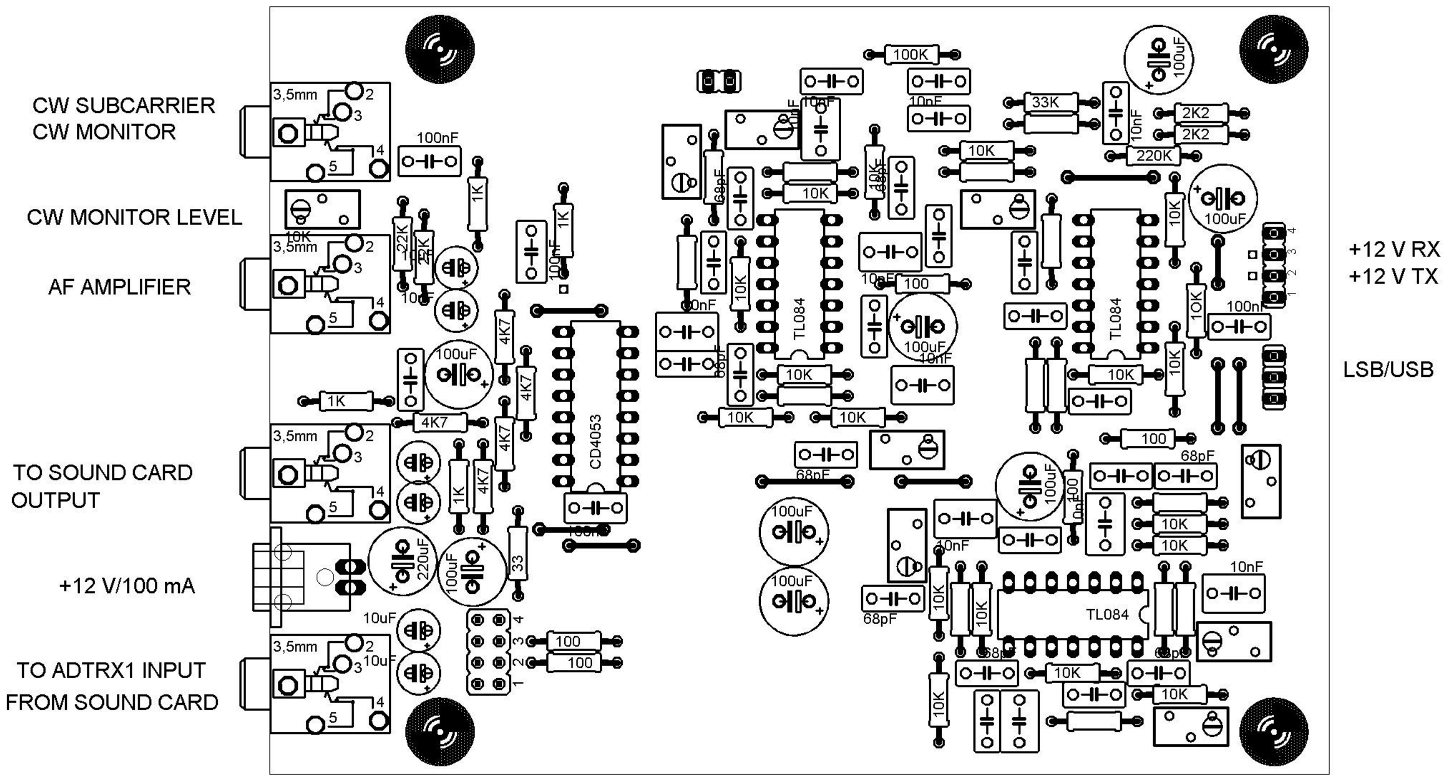
B1A control board single side PCB dimension 92 x 125 mm

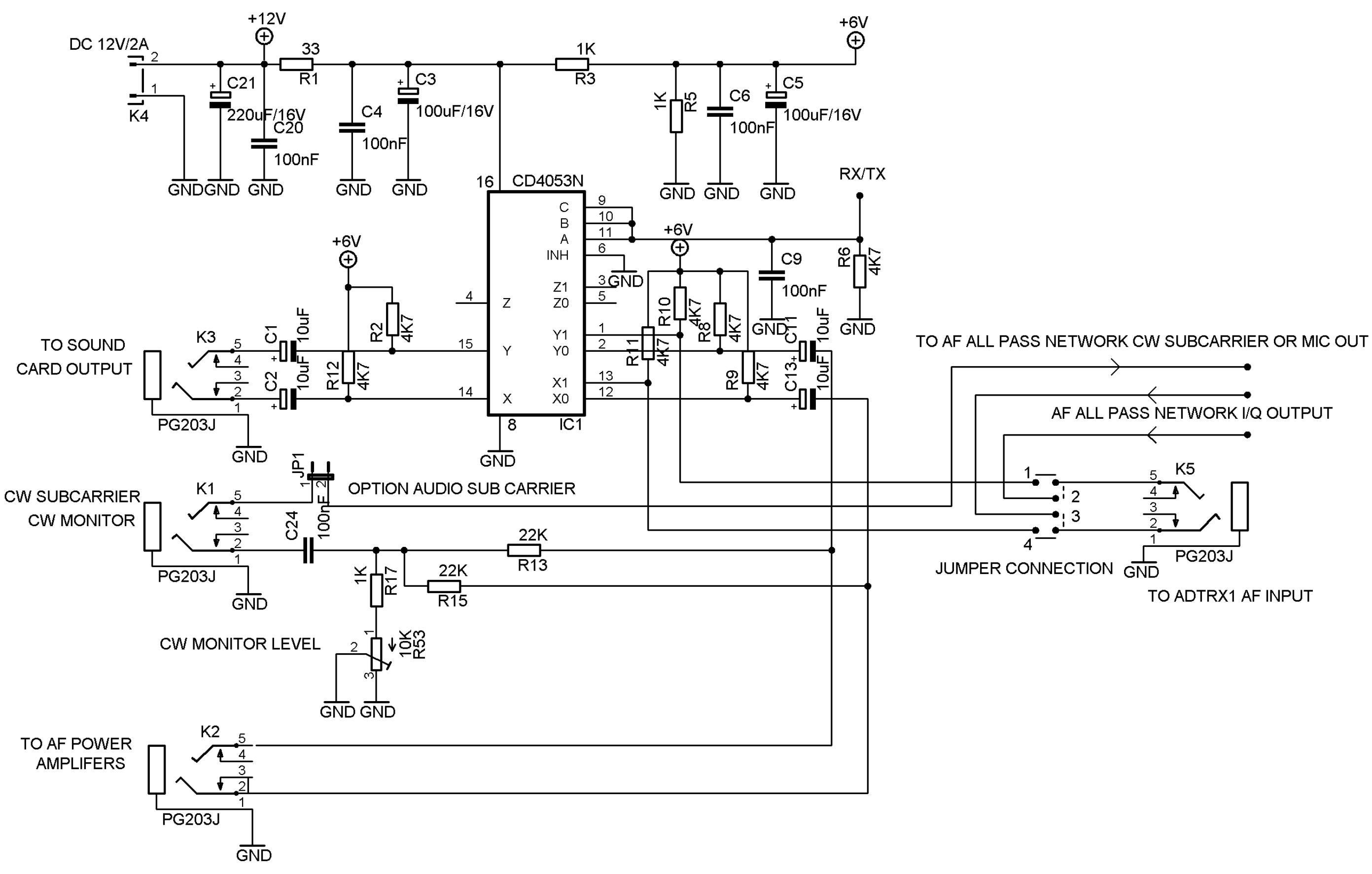
3. *Third way* – For the SDR transmission I am using the same hardware as for the first way only it is necessary to solder option components. The biggest difference is in CW transmission at fixed audio IF frequency. Changing transmitting frequency is possible only with changing LO frequency not as it is in first way where with the fixed LO frequency we can make transmission in of min range +/- 20 kHz or more around central frequency. This way is the way of CW operation with maximum speed keying with min delay between receiving and transmitting as most operator learned.

3. Second way- For SDR transmission I am using the new hardware 4 PCBs. The PCBs order is B2 PCB, ADTRX1-V1, B1A2 PCB and AF amplifier reduced B1A1 PCB. The third way is a classic phasing type SSB/CW transmitter. I made a great effort to find optimum way and simplest hardware solution and realization. Two options was in my focus from the very beginning classic phasing type transmitter and transmitter with Weaver type transmission. With both options I obtained similar results. I decided to publish in this moment classic phasing type transmitter. Reason is a quite simple Weaver type transmitter need more space than it is ADTRX1-V1 PCB.I didn't succeed made a PCB with this transmission options in desired dimensions 125 x 92 mm. I will try to publish this very interesting results as separate project in soon future because there are very small number articles related to this Weaver subject called third method of obtaining SSB... The phasing way of transmission with all pass AF phase shifter I am publishing as separate articles please read ***AF all pass quadrature networks practical approach.*** You need only to make choice what you want to do and than solder adequate components. B1A2 PCB is combination PCB from audio AF phase network and B1A1 PCB. For second way we need 4 PCBs ADTRX1, B2, B1A2 and audio power amplifier for B1A2.

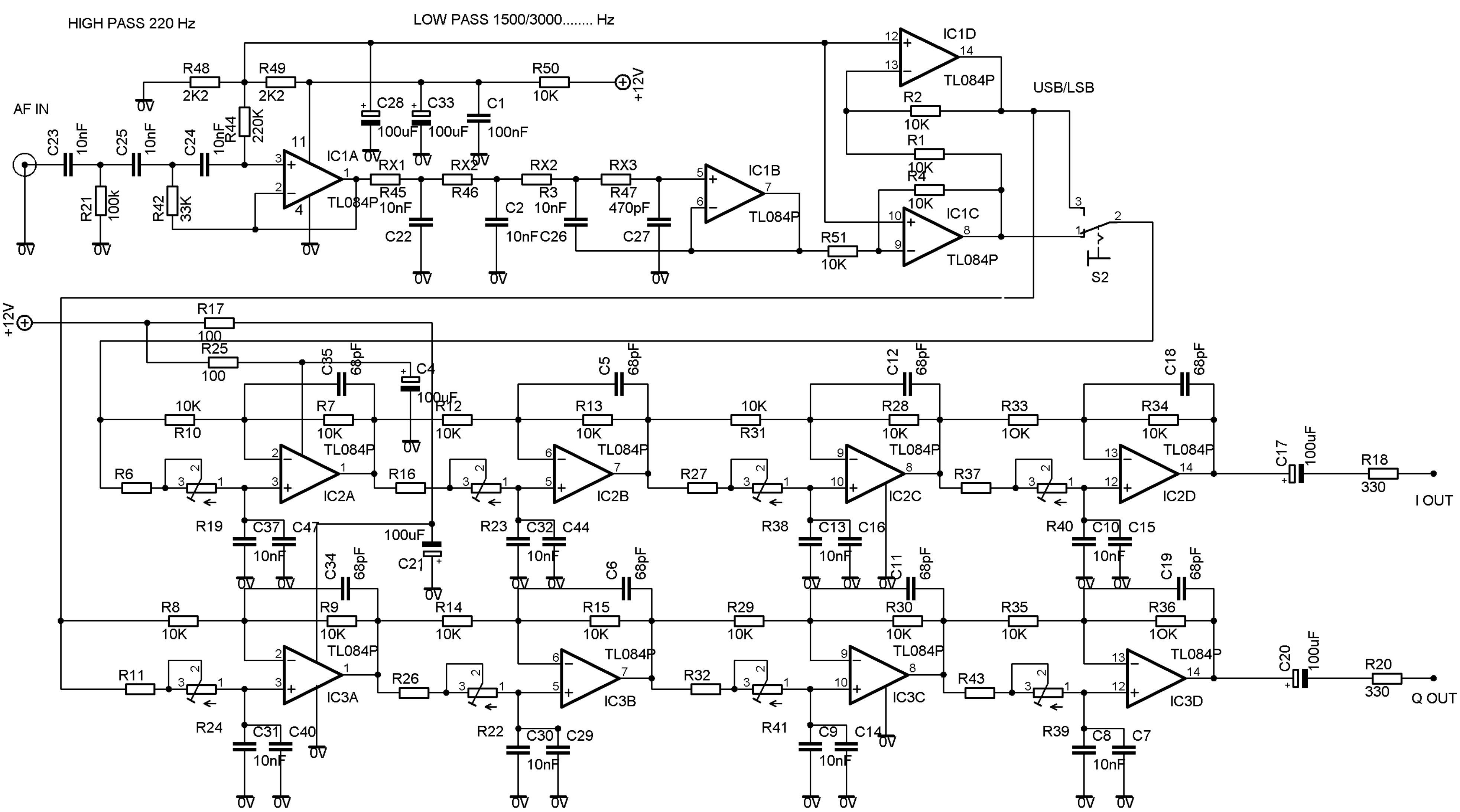


B1A2 Single side PCB dimension 92 x125 mm

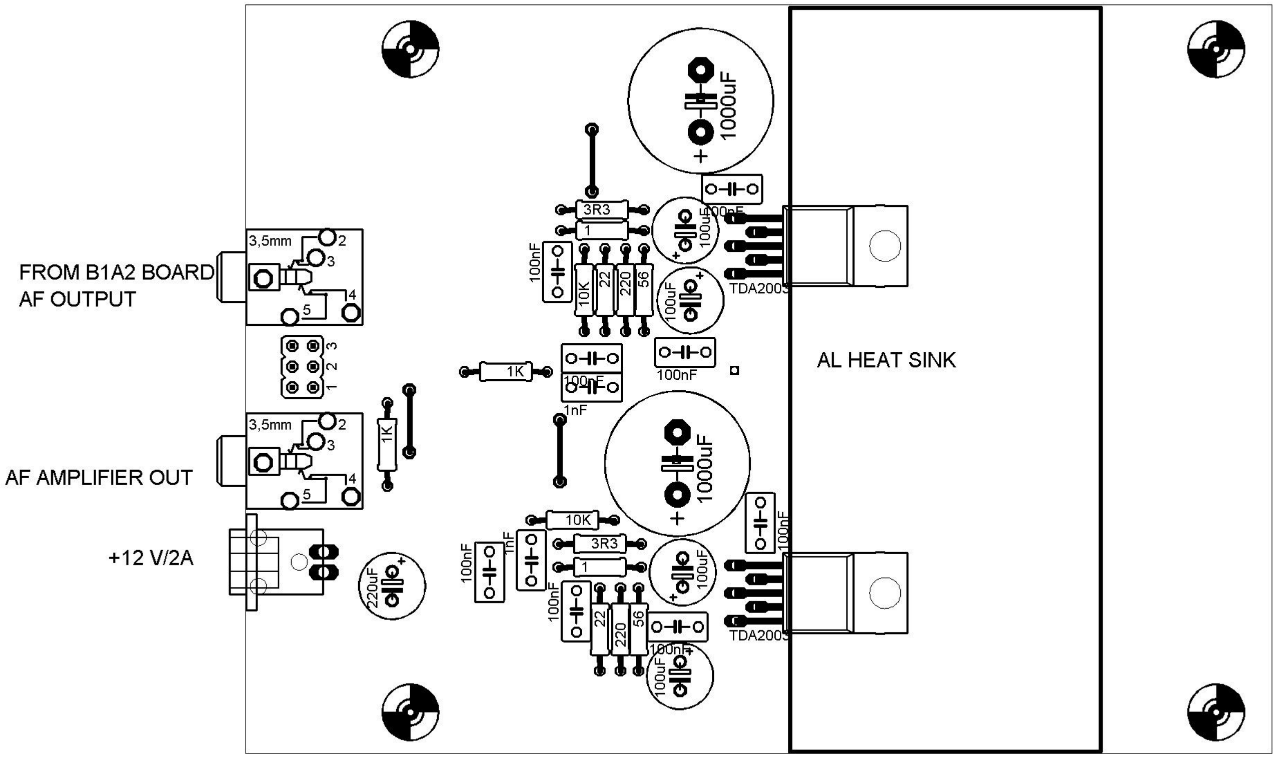


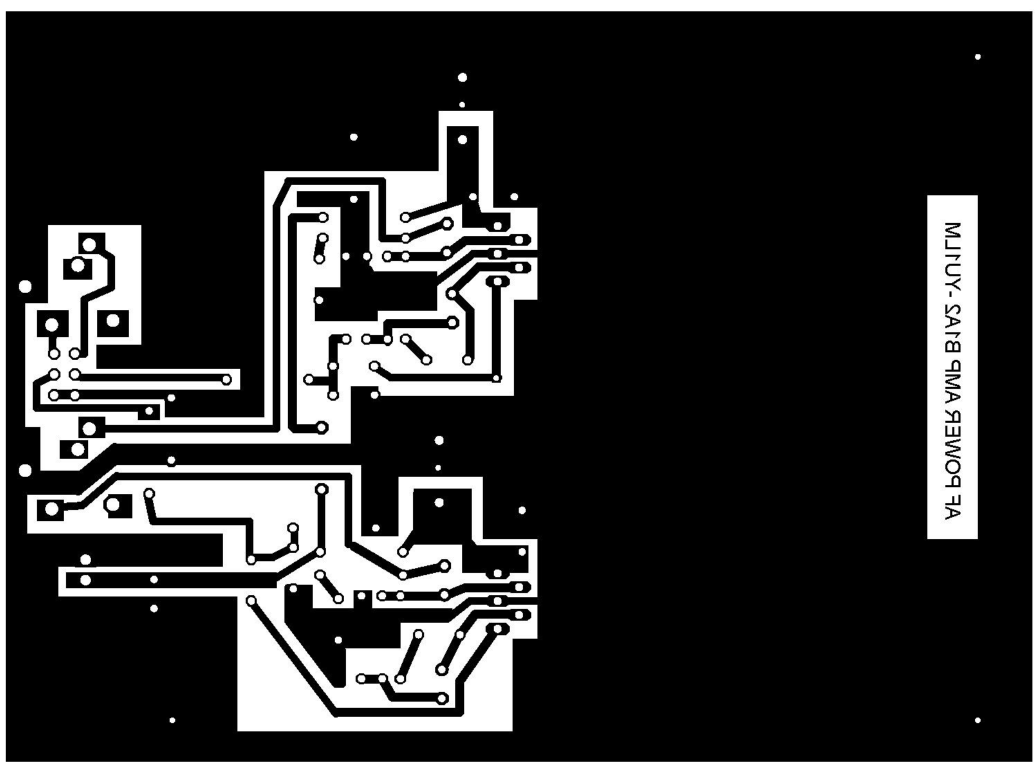


CONTROL BOARD B1A2 - SHEET1

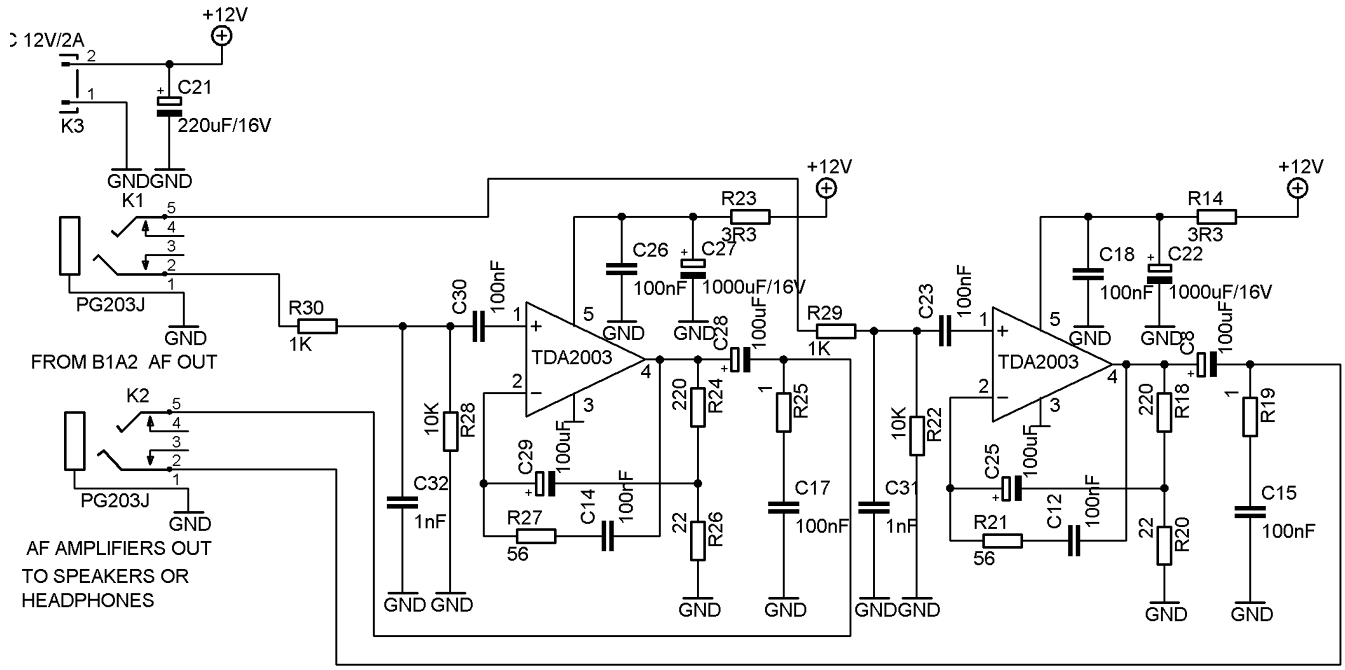


AUDIO ALL PASS PHASE SHIFTER
YU1LM/QRP





Audio 2 x 3 W power amplifier, single side PCB dimensions 125 x 92 mm



AUDIO AMPLIFIER FOR B1A2 BOARD - YU1LM/QRP

In practice:

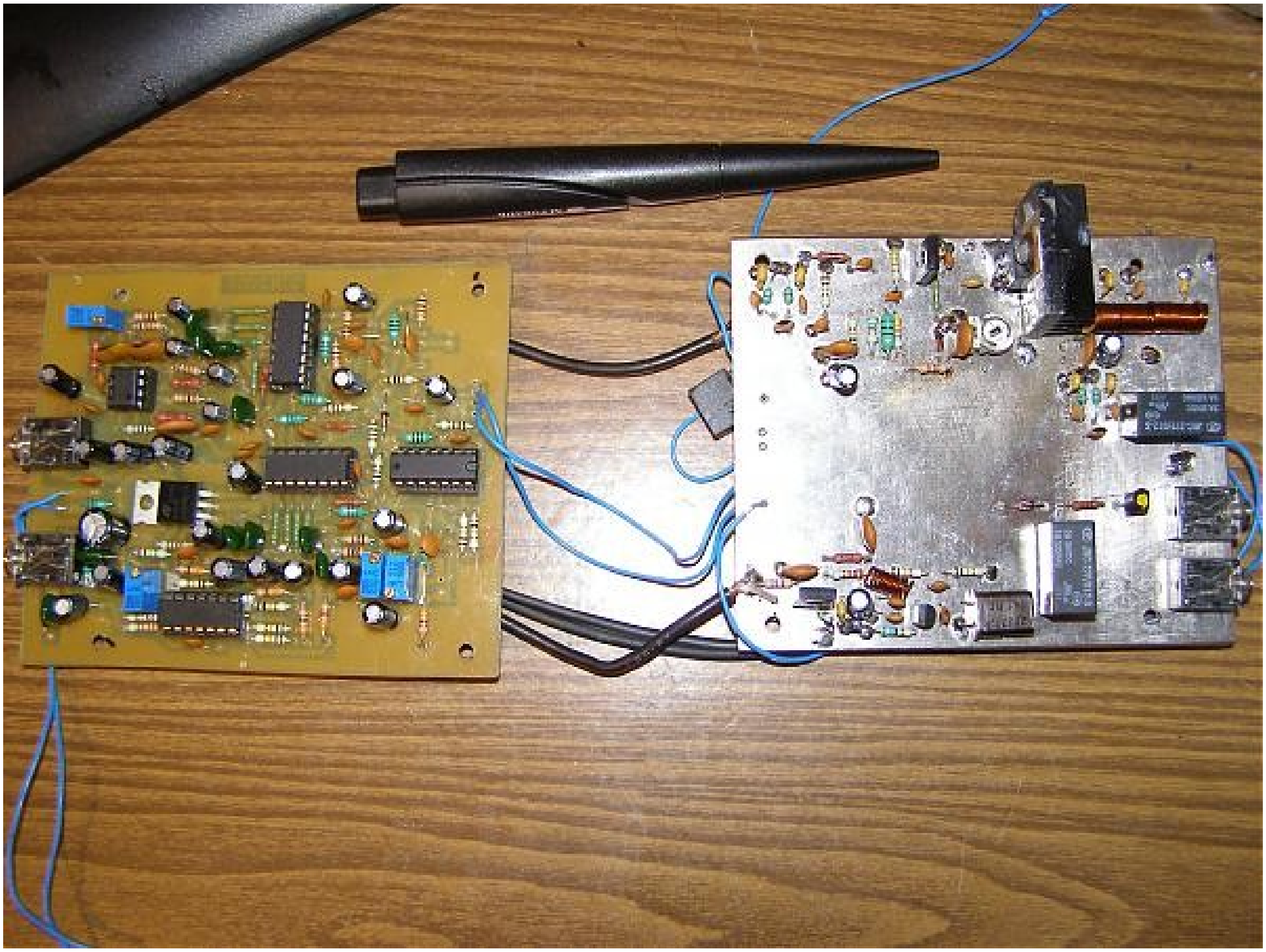
I made successful CW, SSB and Digital operation but only several QSOs were in the "air". My biggest problem is a lack of free time and my family little misunderstanding for wires all over the tables in apartment. From other side I am lazy to finish designs in BOX for me all is never ending story and I always see some alternative way or new possibility in any design. This homebrew designs are my hobby in which I enjoy very much. If I have to "cut" some things in professional life to finish at time for my hobby this isn't necessary thing.

Digital operation is possible now with only one SB card with help virtual cable software VAC 4.03 (see FLEX Radio site for installation and down load) or how this does Patrick F6CTE with his freeware famous software MULTIPSK. MULTIPSK I can say that have all digital modes in practical use today. Alternative way for digital transmission is use 2 SB cards, one for SDR receiving and second for digital receiving and transmitting. I made digital operation at that way first and I have admit that this way consume a lot of PC CPU power and for slower PC is practically impossible. Last version PowerSDR from FLEX Radio have big improvements in possibilities and speed and now it is relative easy to do CW/SSB and digital operation see screen shot from PowerSDR (KD5TFD version for Softrock transceiver) in last WW CW 2006 contest on 7 MHz.

Picture up screen shot from ADTRX1 SDR transceiver RX screen – I was receiving clear and loud without problems, band 7 MHz, VK6LW signal close to the noise level. VK6LW signals was 100% readable in present of the close very strong signals 50 dB stronger 1 kHz down, 200 Hz down 20 dB stronger and 25 dB stronger 350 Hz up!!!

It was really great pleasure listening low HAM bands and see how SDR receiver is superior in performances to the most very good classic transceivers. Only little deficiency is still not too much comfortable operation during transmission /receiving with many software at the same times (SDR program, DDS control, contest log…). My hardware is not 100 % compatible with SDR1000. I have separate program for DDS but when I am changing PowerSDR setup it unpredictably change frequency from time to time because I am using same LPT port for DDS programming. I have to be "Speedy Gonzales" to make delay in operation little noticeable HI!!!! I have to do investigation how to make operation optimal for the sure. I didn't test Duncan M0KGK transceiver software yet to see how it is comfortable for practical operation.

Some other SDR fans made ADTRX1 transceiver and made successful operation. I am presenting here practical experience from Andrey (Андрей Мисюрко) US5EQQ which made 7 MHz single band SDR transceiver. Andrey is using very cheap computer surplus quartz 28.322 MHz. See his ADTRX1 transceiver and PC setup and results he accomplished down.



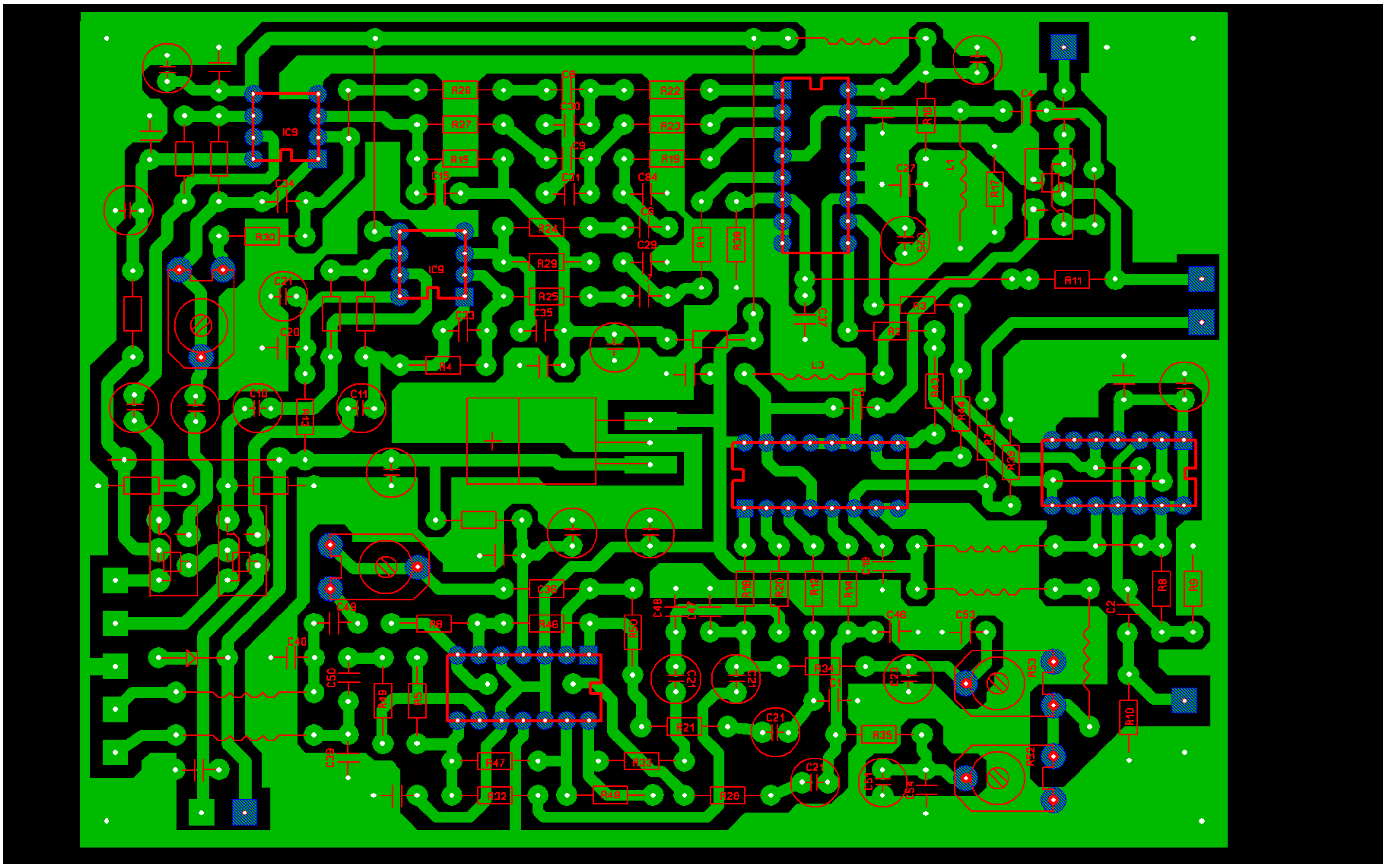
PC AMD 3100 MHz , RAM 512MB , Audio card CREATIVE AUDIGY 4

1. Sensitivity for 10 dB S/N better than 1 uV
2. Carrier suppression 60 db
3. Opposite band suppression 40-60 dB in receive and transmit mode
4. Output power 1 W realized with 2SC2078 transistor
5. Software PowerSDR version KD5TFD

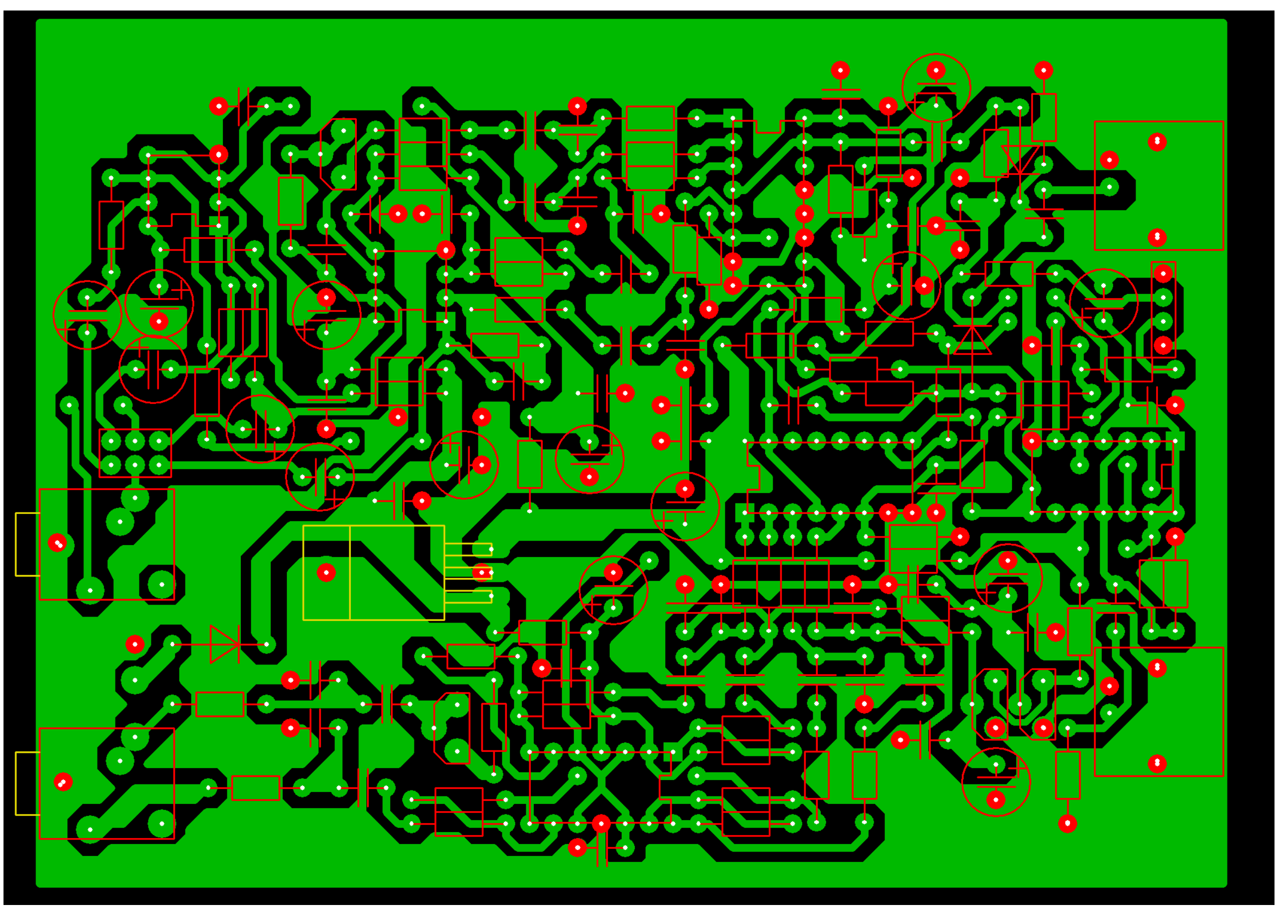
I wish you successful AFTRX1 realization and I apologize for the some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Send me your comments positive or negative anyway, results or photos of your realization please. In part 3 I shall publish simple QRP power amplifier and quartz XTAL oscillators for the few band operation 2 or 3? Transmitting HAM band are harmonically related (for example 14, 7 and 3.5 MHz)

GL 73/72 Tasa YU1LM/QRP tasa@imtel-mikrotalasi.co.yu

Some guys like Gennady UA6XW/9 made similar PCB for ADTRX1-V1 with little different placement and with relay switching. See his realization down first picture.



Here down is also PCB for ADTRX1-V1 made by UR3VCD



References:

1. ***www.qsl.net/yu1lm/homebrew***
2. ***www.yu1lm.qrpradio.com***
3. ***http://forum.cqham.ru/viewforum.php ?f=28***
4. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
5. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
6. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
7. ***http://www.njqrp.org/mbrproj/9850dds.html***

www.analog.com/en/prod/0,,770_843_AD9850,00.html

http://www.qsl.net/pa3ckr/signalgenerator/

http://www.k6ese.com/DDS_Project.htm

http://ham.kiev.ua/pic/dds_ham2.html

http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

http://members.aol.com/Dl4JAL/DDS.html

http://hem.passagen.se/communication/dds.html

8. ***Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53***
6. ***RF Design 6/1995***

Software LINK for SDR radio receiving and transmitting

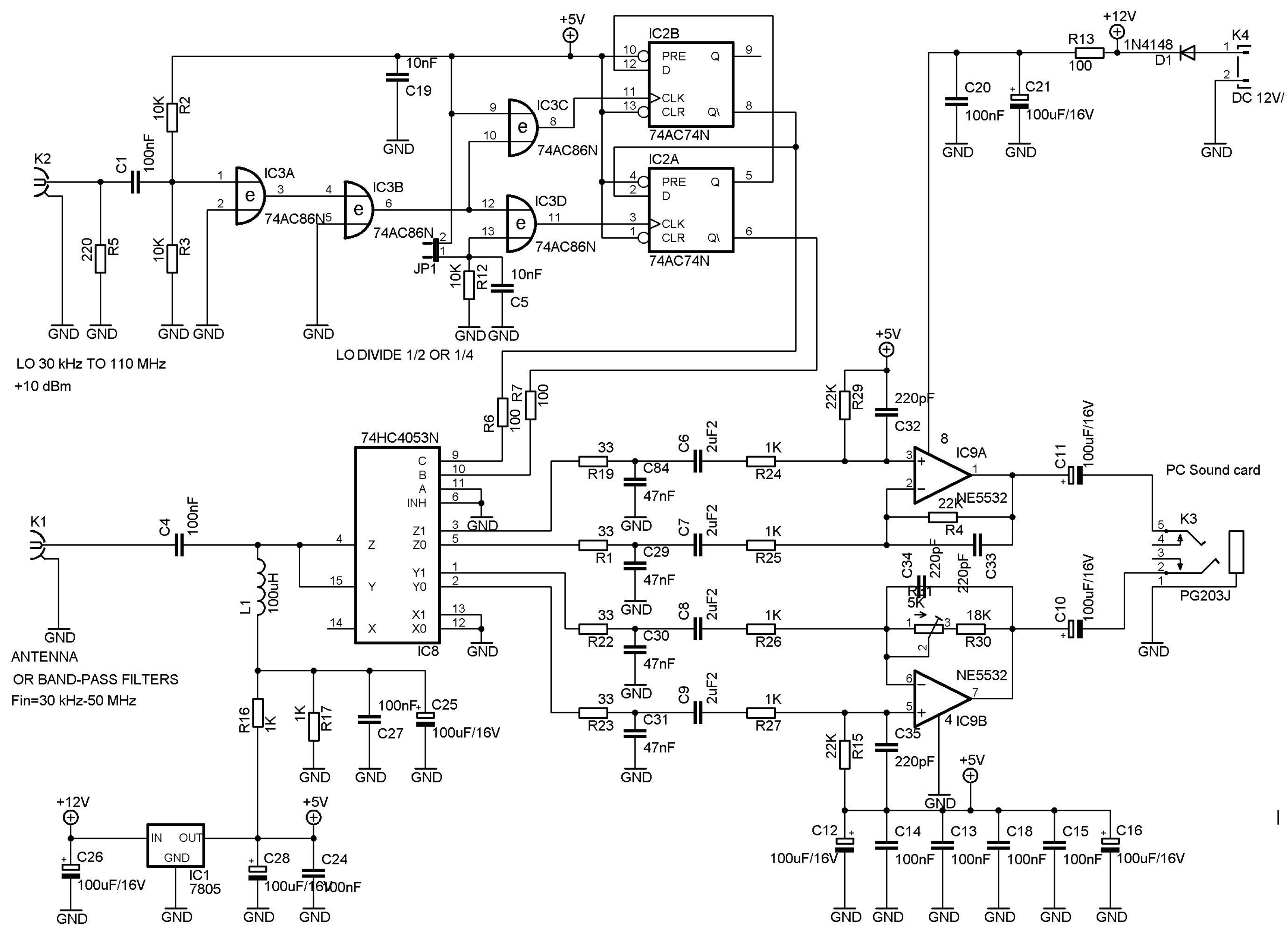
1. ***www.weaksignals.com WINRAD,SDR0.99***
2. ***www.ciaoradio.com***
3. ***www.m0kgk.co.uk/sdr***
4. ***www.g8jcf.dyndns.org Peter G8JCF***
5. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
6. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
7. **dl6iak.ba-karlsruhe.de**

HF SDR S/H Sample and Hold Receiver DR2D from 30 KHz to 50 MHz-Make it Simple as Possible with Outstanding Performances

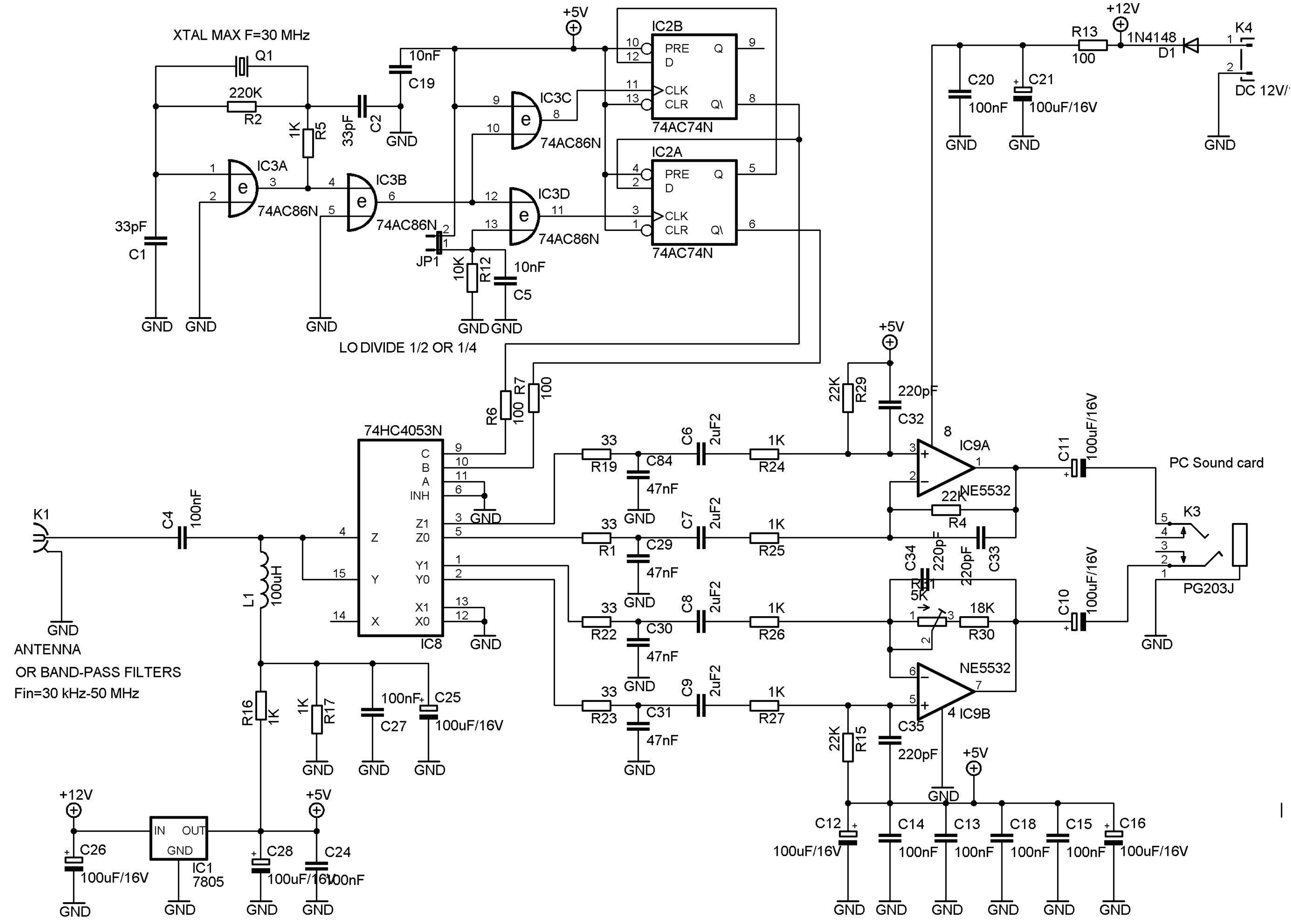
Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A…. You can see some photos on my sites and I can emphasize that they are all satisfied with results. Simple constructions with cheap classic components are working really very well. All SDR receiver designs have some positive and some negative aspects of design.

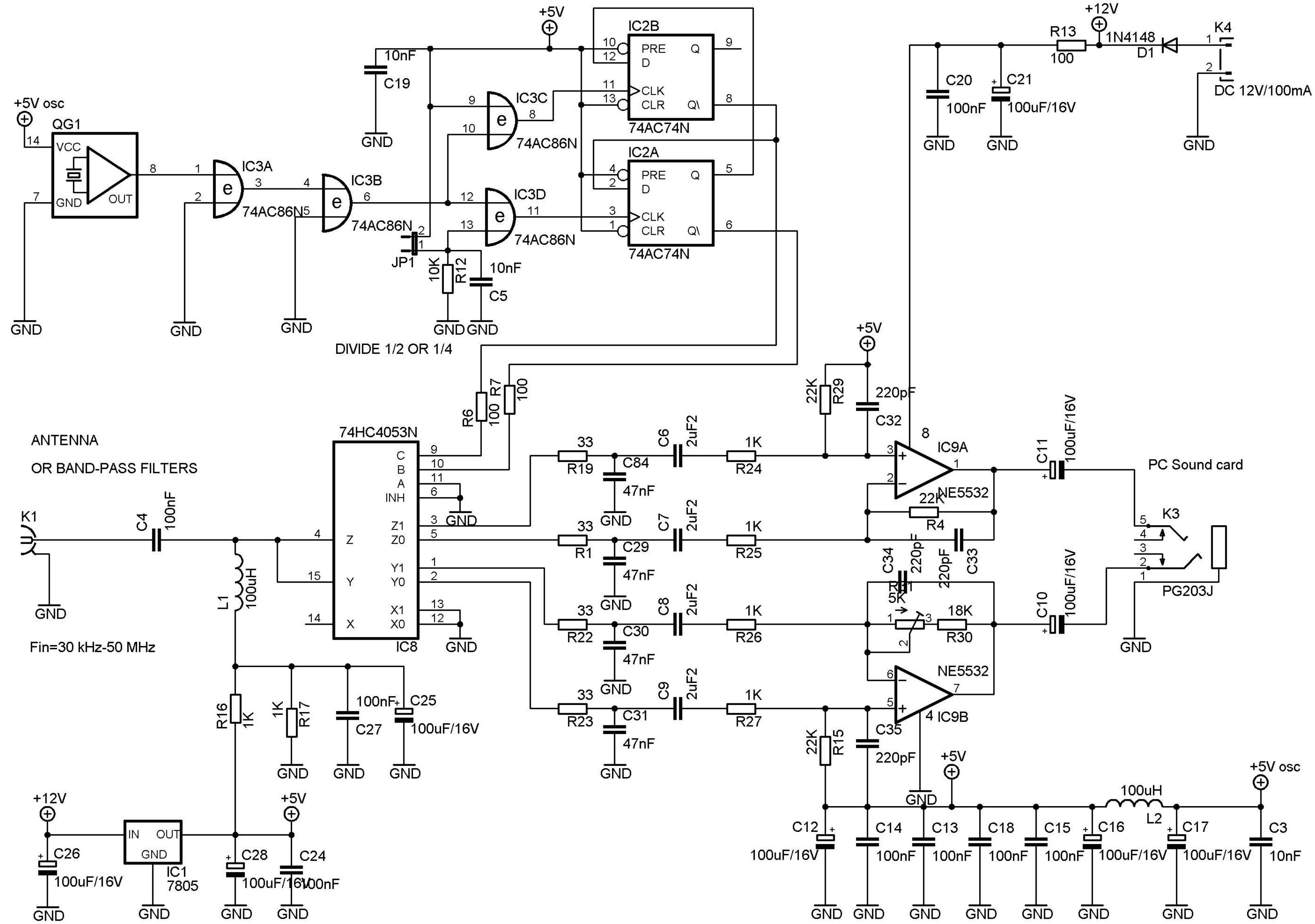
Let's start from the beginning. The DR1 and DR1A receivers have built-in oscillators and they are without image rejection possibility. DR2C has built-in oscillator but it is for one band ,only like Softrock KIT and it hasn't optimum design. The DR2, DR2B and DR2A are receivers for external LO connection and they have the best performances because image rejection possibility. The DR3X is using positive side of design from previously mentioned receivers. Last group receivers and DR3X have the biggest disadvantage because it needs 4 times higher LO frequency then receiving one. From the maximum receiving frequency point only DR2C is arriving to the 6m (50 MHz) but it hasn't optimum design. Many SDR fans are using DDS AD8950 like I do. The AD8950 disadvantage is max output frequency around 60 MHz. This Nyquist limit lead to situation that we can receive max 15 MHz with my best receivers DR2, DR2B and DR2A (limit is 74AC74 IC limiting Finmax to 35 MHz). I proposed in part 2 alternative way for the obtaining I/Q quadrature LO drivers with 74AC74 and 74AC04. This proposal has negative side that we have permanent error several deg. phase max error to 4-6 deg. On Russian forum, see link down, I saw very interesting idea from Jurij UR5VEB for obtaining LO I/Q signals with EXOR IC 74AC86 dividing with 2 or 4. This idea have also negative aspect because dividing with 2 introduce similar phase error like mine proposal. It is very hard obtain square signal with 50/50 duty ratio without dividing with FF flip flop. The idea has positive side because it is possible to obtain an optimum I/Q LO drive dividing with 4. I decided to check this idea with "dead bug" construction and ADTRX1-V1 RX. The results I obtained verify my expectation that results are similar to my proposal early mentioned. My new idea is that for the higher frequency over 15 MHz to 50 MHz we can use non optimum phase shift. The phase error we can compensate in software. For the frequency lower than 15 MHz where max performances are vital specification we can back to the normal optimal mode LO dividing with 4. I tested SDR DR2D RX but I didn't make proposed PCB but from fact that all was working fine as dead bug construction, I don't expect problem. This receiver is similar to the DR2B and ADTRX1-V1 receivers. All data, measurements and adjustment are the same. I shall repeat them here. I am giving schematics and proposal for parts placement and PCB. ICs samples of 74AC86 and 74ACT86 was working well to 100- 110 MHz. Over this frequency ICs was not working well, power consumption rapidly increases with increasing LO frequency to over limits values. This characteristic lead that we can have safe operation limited Fin to the maximum 50 -55 MHz. The same frequencies are limit for the used S/H detector 74HC4053 also.



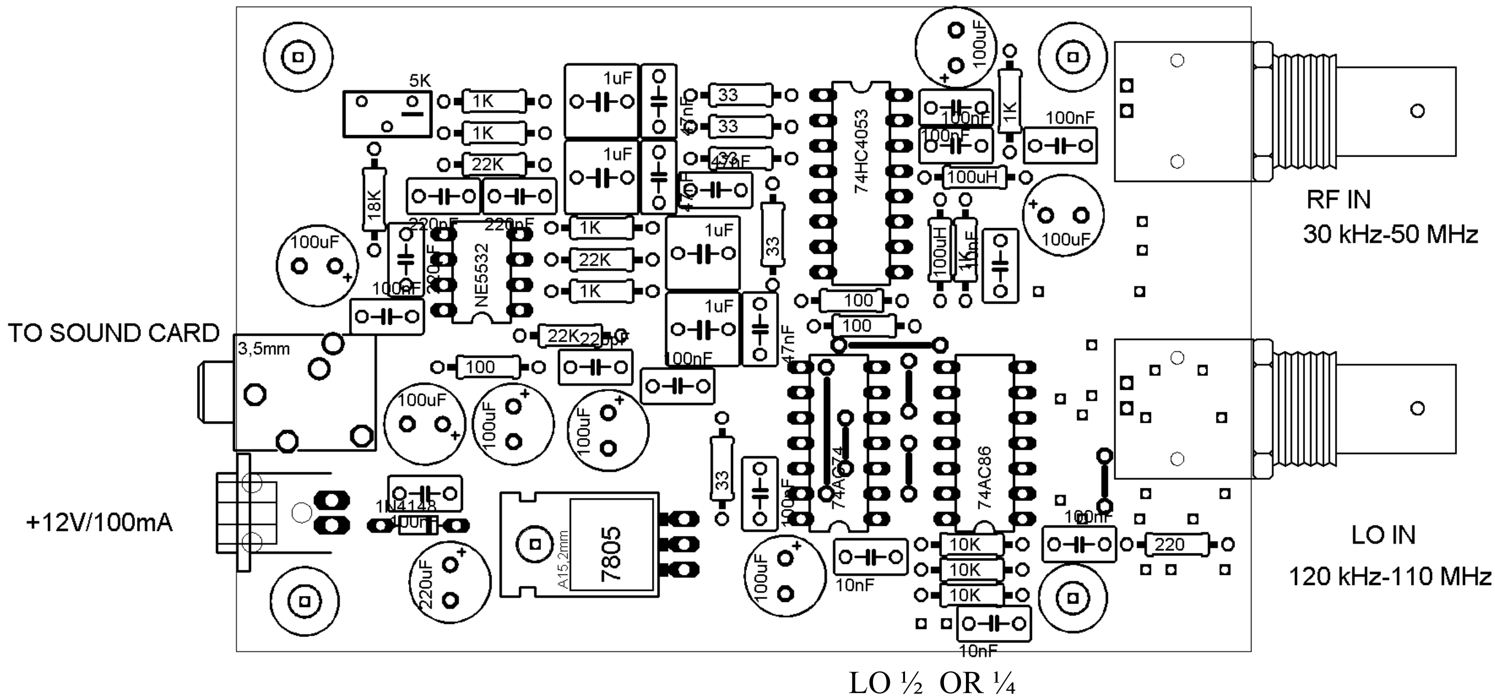
SDR RECEIVER DR2D CONNECTION FOR EXTERNAL OSCILLATOR



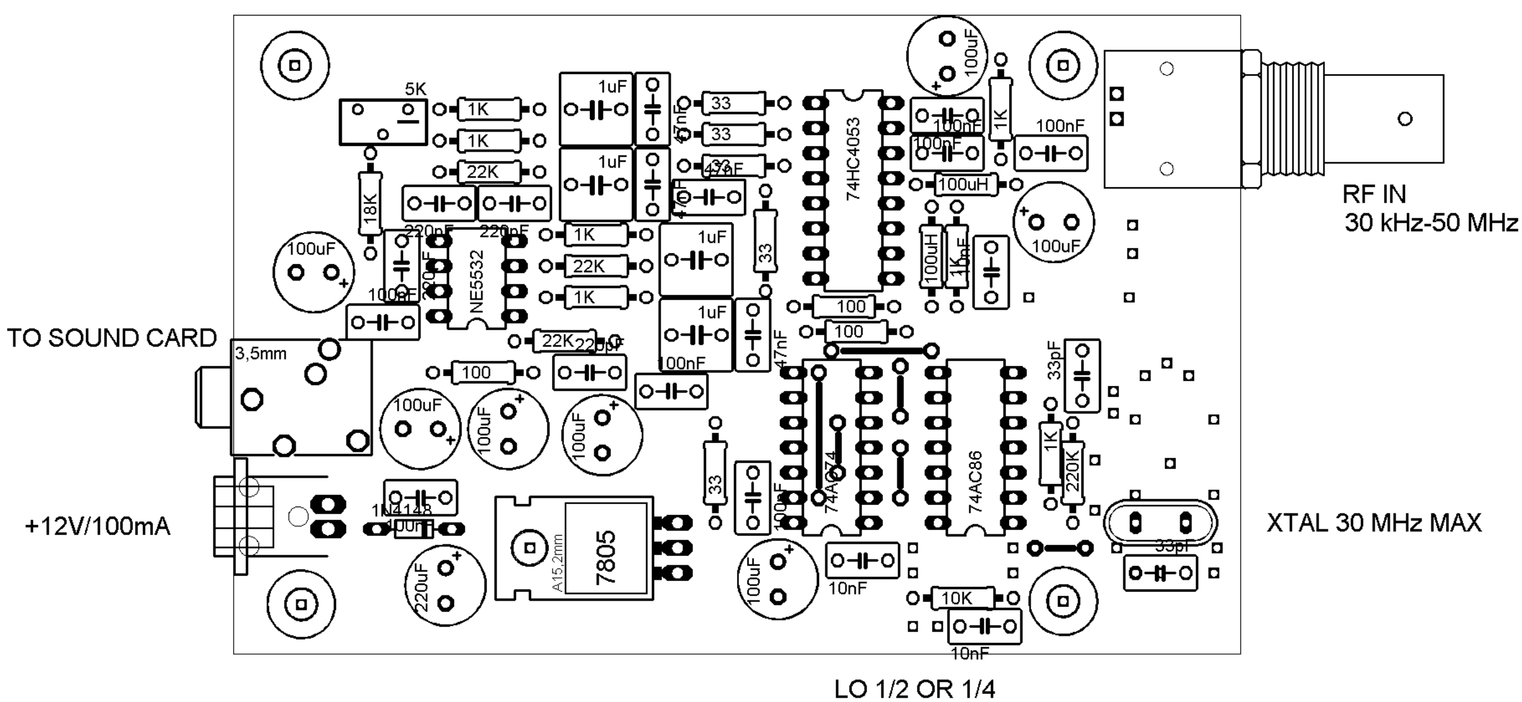
SDR RECEIVER DR2D CONNECTION FOR INTERNAL QUARZ OSCILLATOR



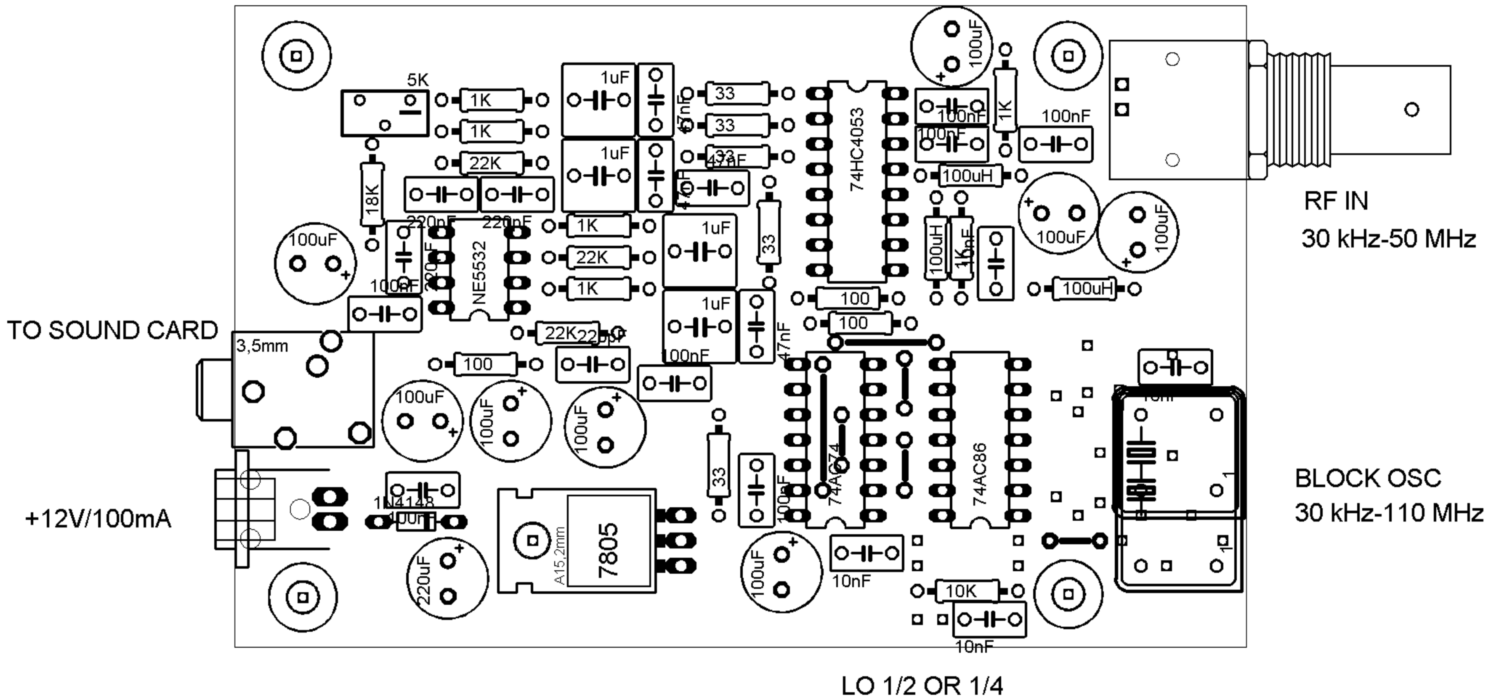
SDR RECEIVER DR2D CONNECTION FOR DIL OSCILLATOR



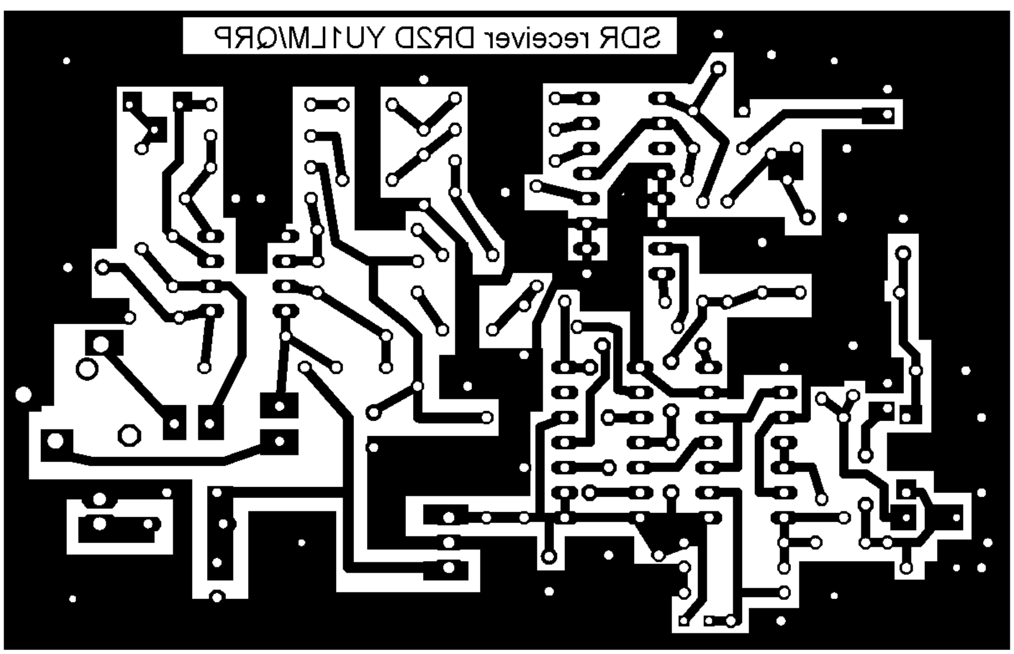
DR2D parts placement for external LO +10 dBm



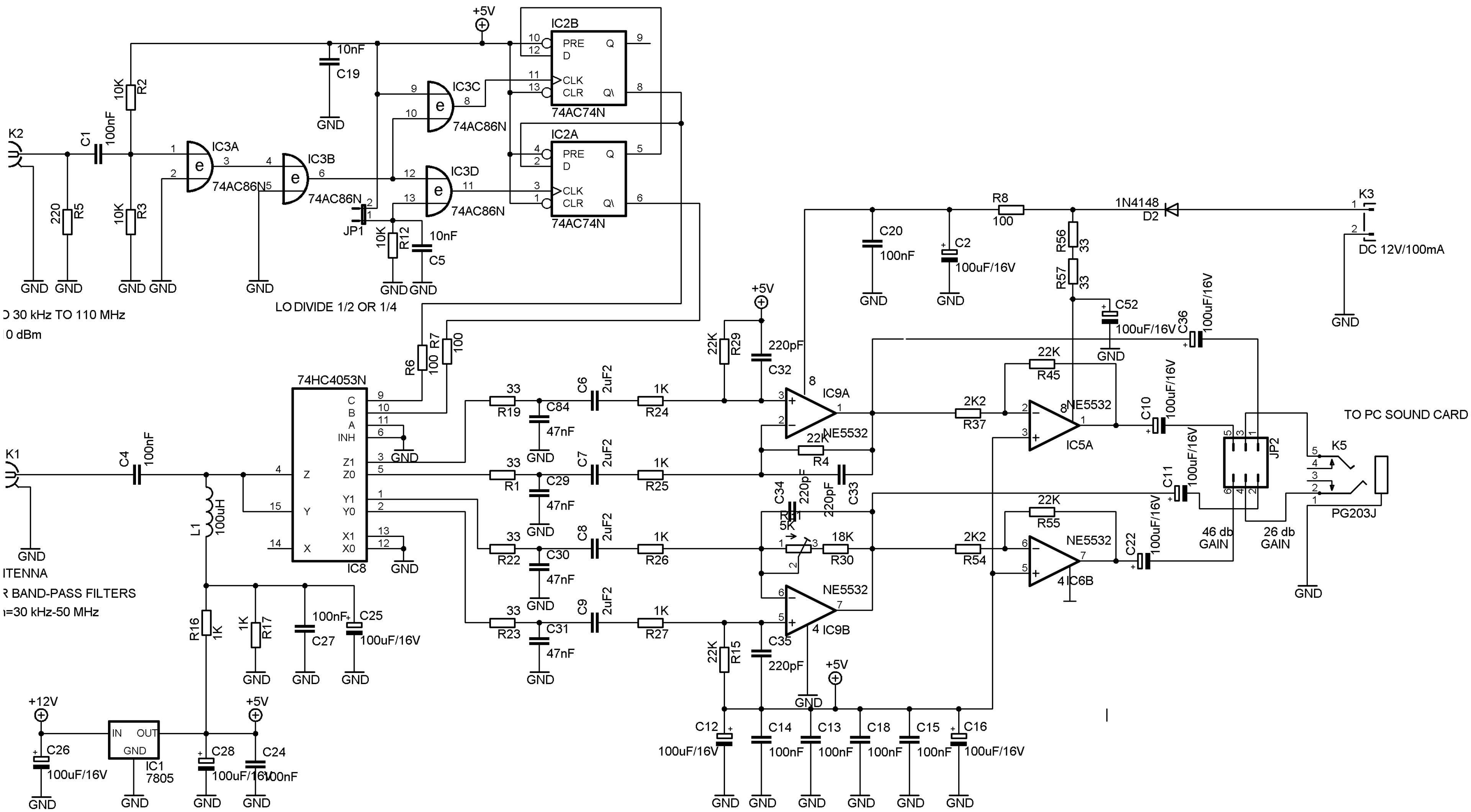
DR2D parts placement for gate XTAL oscillator to 30 MHz



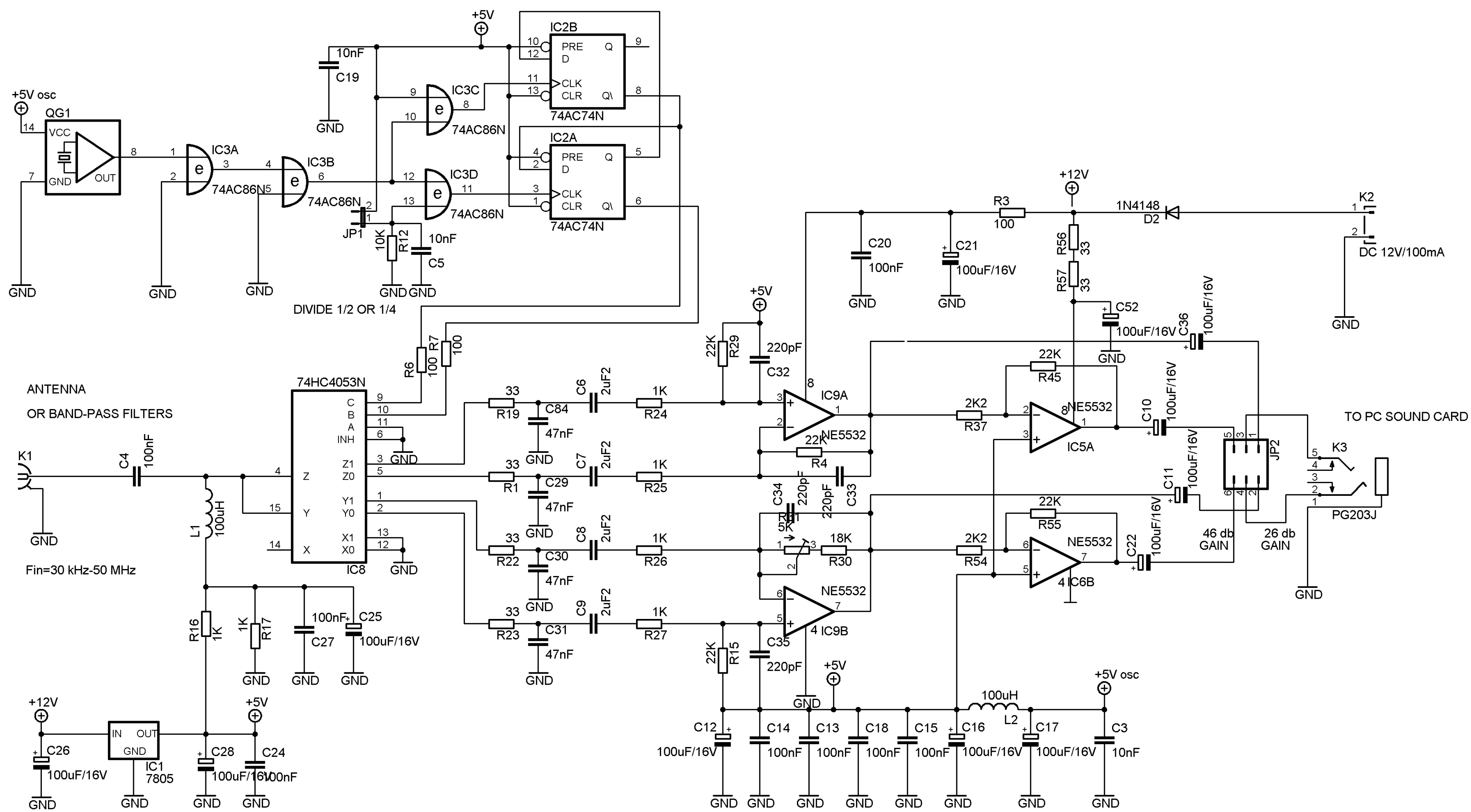
DR2D parts placement for BLOCK oscillator to 110 MHz



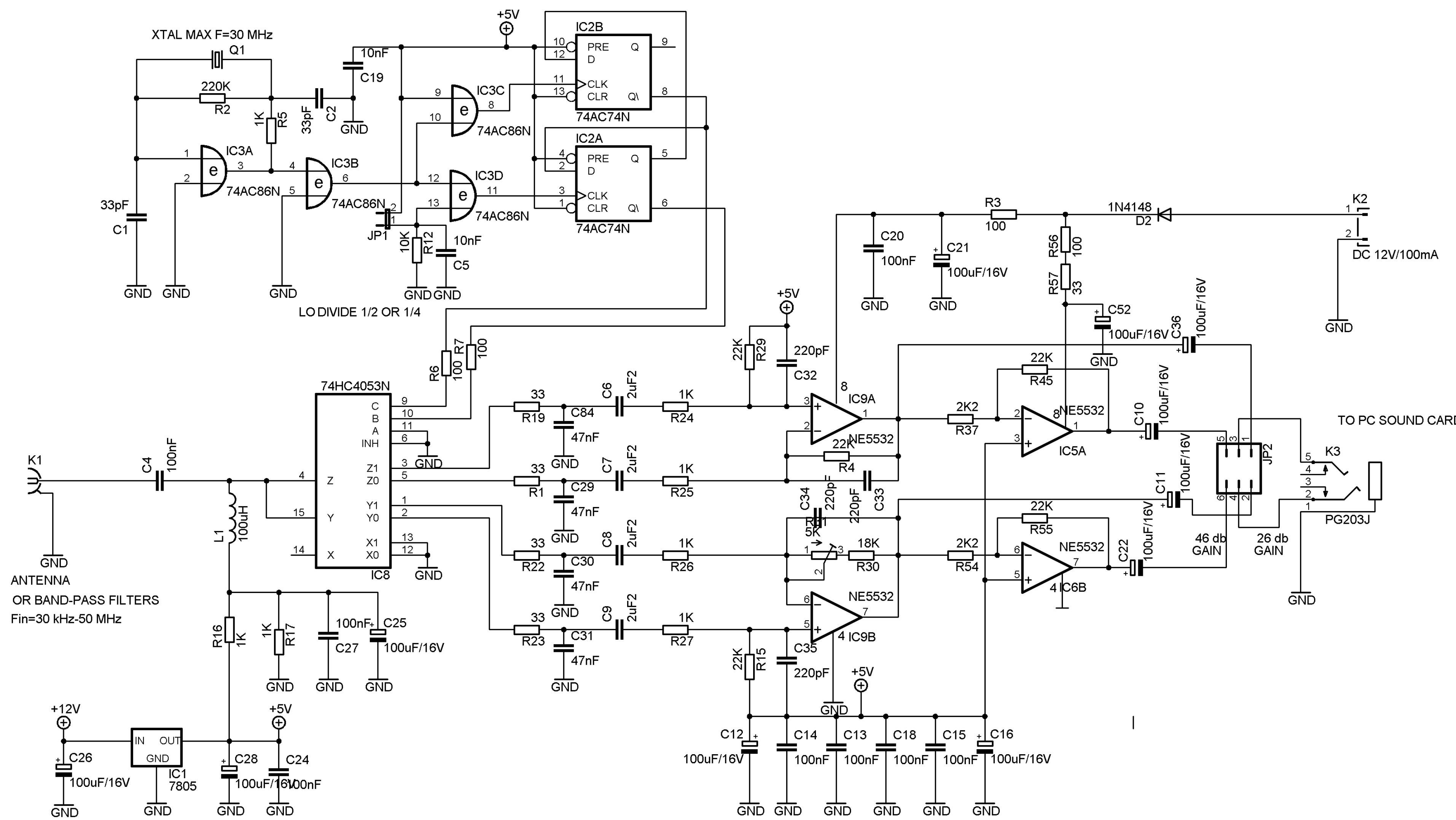
DR2D Single side PCB size is 102 x 65 mm



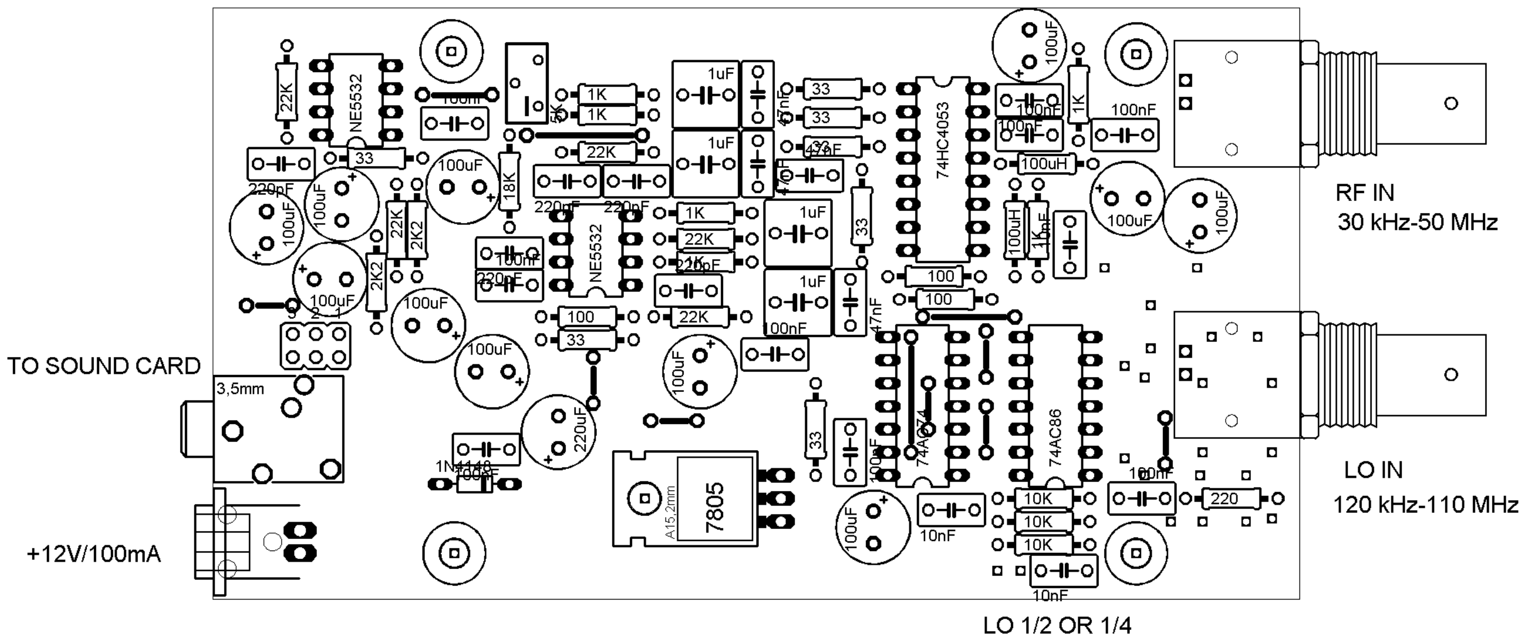
SDR RECEIVER DR2D-1 CONNECTION FOR EXTERNAL OSCILLATOR



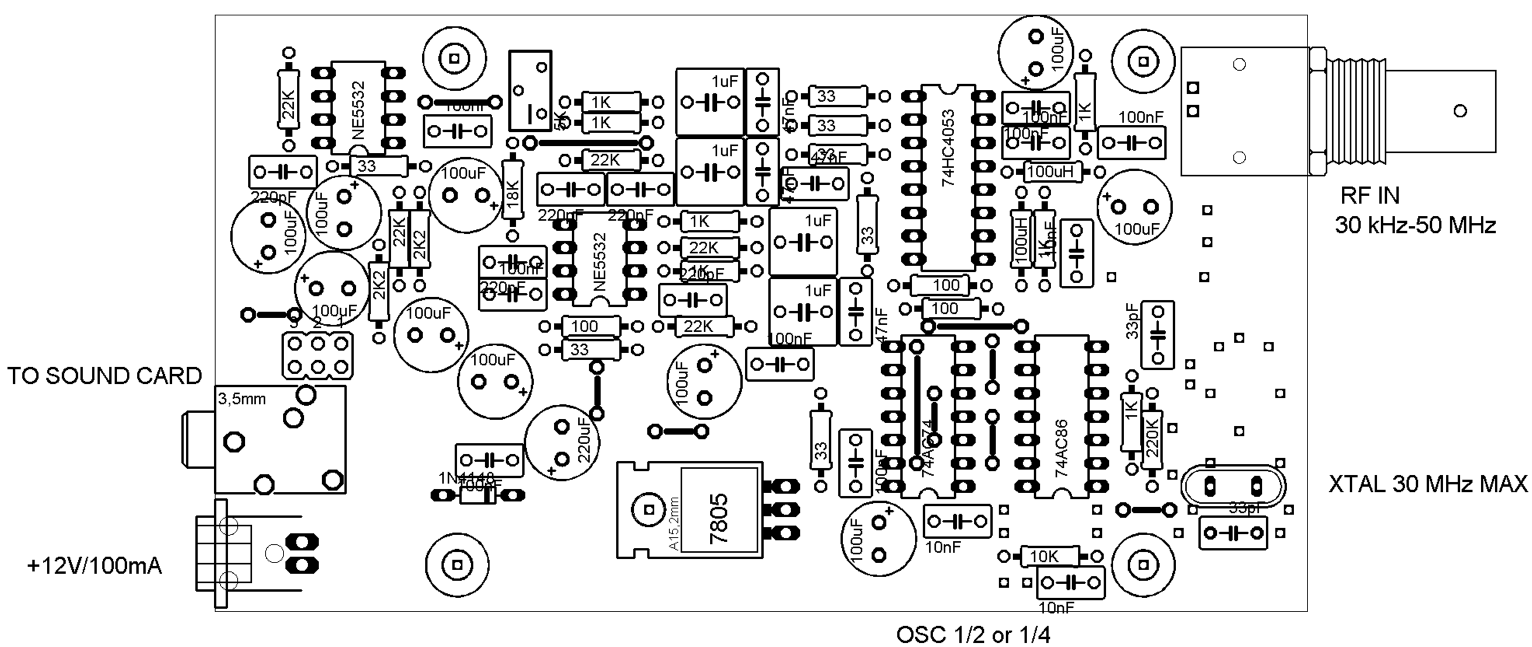
SDR RECEIVER DR2D-1 CONNECTION FOR DIL OSCILLATOR



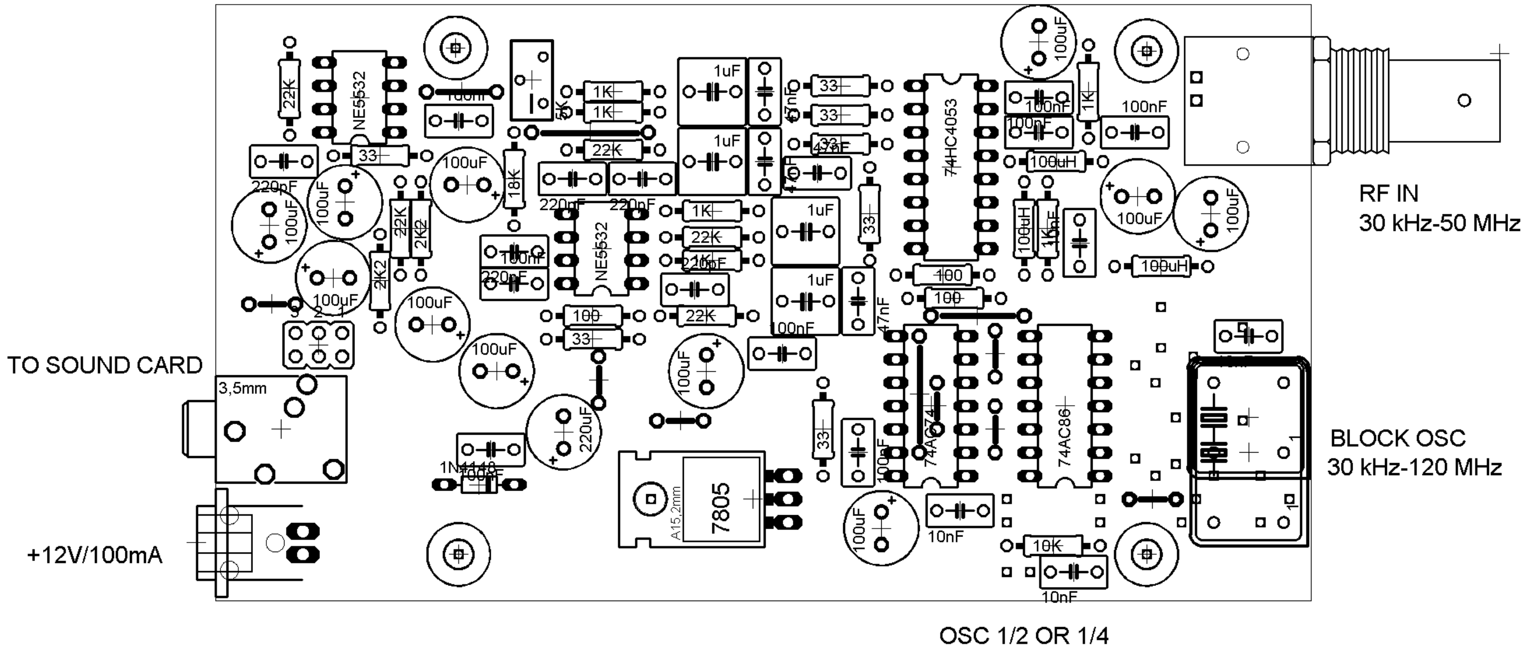
SDR RECEIVER DR2D-1 CONNECTION FOR INTERNAL QUARZ OSCILLATOR



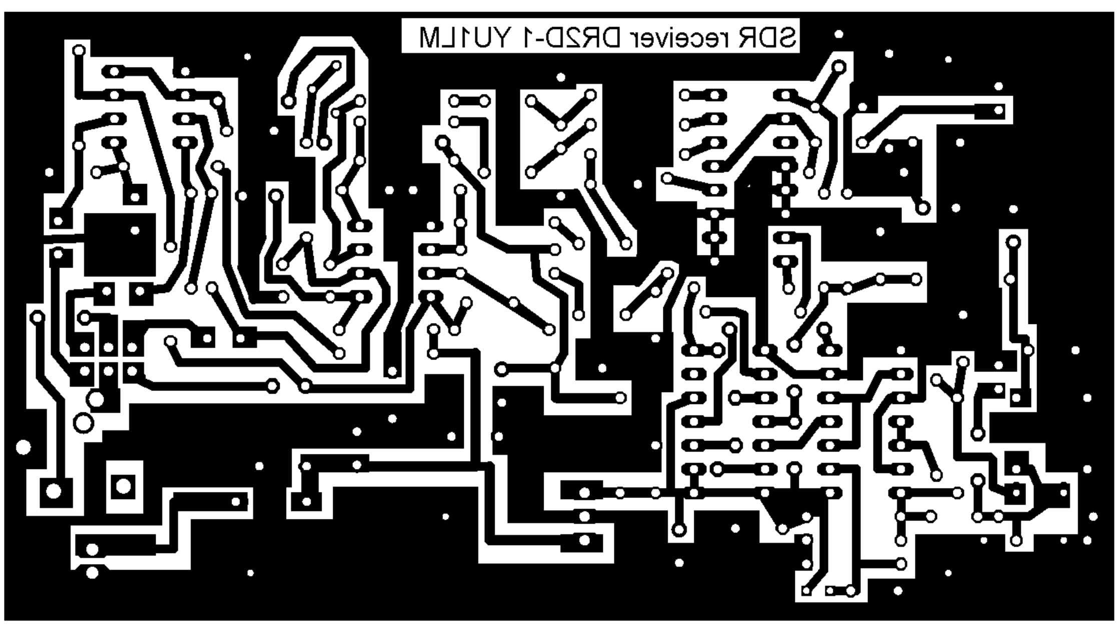
DR2D-1 parts placement for external LO +10 dBm



DR2D-1 parts placement for gate XTAL oscillator to 30 MHz



DR2D-1 parts placement for BLOCK oscillator to 110 MHz



DR2D-1 Single side PCB size is 120 x 65 mm

Measuring results which I made with HF S/H SDR receivers DR2D and DR2D-1

1. Receiving range is from 30 kHz to 55 MHz with external LO. With built in block OSC RX go to 55 MHz.
2. IIP3 24-26 dBm and it depends from setting and used programs. I changed RX amplification distribution. I increased gain for first stage to the 26 dB and decrease gain to 20 dB for the second stage. (Data are measured with 24 bit sound cards).
3. MDS is -106-110 dBm also with 24 bit external USB SB card Audigy NX2
4. Image rejection is going from 35 -40 dB for upper band from 15-55 MHz and 45-60 dB for the frequencies lower than 15 MHz all measured 12 kHz from the central frequency..
5. Sensitivity is 1-3 uV for 10 dB S/N ratio, max S/N ratio I measured was 67 dB.
6. SFDR (Spurious free dynamic range) is 84-89 dB, this results are with signals spaced 5 kHz and more. Results aren't changing very much if we increase space between two signals to classical 20 kHz or more.

Some excellent performances with 4 IC are not without other side:

1. The first and very big disadvantage and advantage at the same time is 2 or 4 times higher LO
2. Image rejection is changing through receiving bands and results are done for the frequencies 12 kHz away from central frequency. We also have problem with non equal work with dividing mode as I explained when we are choosing ½ or ¼ dividing ratio.
3. For external LO it is necessary input level around 1 Vp-p min for safe operation (for lower LO drive operations are not sure especially for higher LO frequencies)!!!Simple test shows that IC 74HC4053 is working correctly that we can measure with DMM (digital multi meter) Vcc/2 or 2.5 V +/-0.1 V at pins 9 or 10. If it is not true we have a problem with input LO level or input ICs 74AC74 or 74AC86

DR2D adjustments are simple and done in two steps:

1. Adjust with universal instruments DMM (digital multi meter) that resistance in feedback potentiometer is 5K +18K = 22 K.
2. Find some strong signal in the air 12 kHz away from zero or put signal from the generator to the input of DR2D or DR2D-1 and with 5 kOhm potentiometer adjust min unwanted image signal in some SDR program. Additional image rejection adjusts in SDR programs if this possibility exists function such as skew in Alberto I2PHD programs.
3. There are two possibilities for solving problems with phase error previously mentioned. The phase error is result of non-equal duty ratio with square shaper IC 74AC86. The first one solution is to solder 1 small C values between 1-5 pF to control signals PIN 9 or 10 IC 74HC4053 after resistors of 100 Ohms observing in some software for example Rocky to see in which direction is error going. If it is increasing than it is necessary to solder to other PIN. This adjustment is necessary to be done at the highest receiving frequency. Alternative way is to do same action observing RX SDR software phase error. In the case of external LO adjust the resistance R3 10 kOhm to the ground to obtain min phase error.

I wish you successful DR2D or DR2D-1 realization and I apologize for some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP
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References:

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2. ***http://forum.cqham.ru/viewforum.php ?f=28***
3. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
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6. ***http://www.njqrp.org/mbrproj/9850dds.html***

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HF SDR S/H Sample and Hold Receiver DR2-2 receiver without any coils from 30 KHz to 40 MHz-Make it Simple as Possible with Outstanding Performances

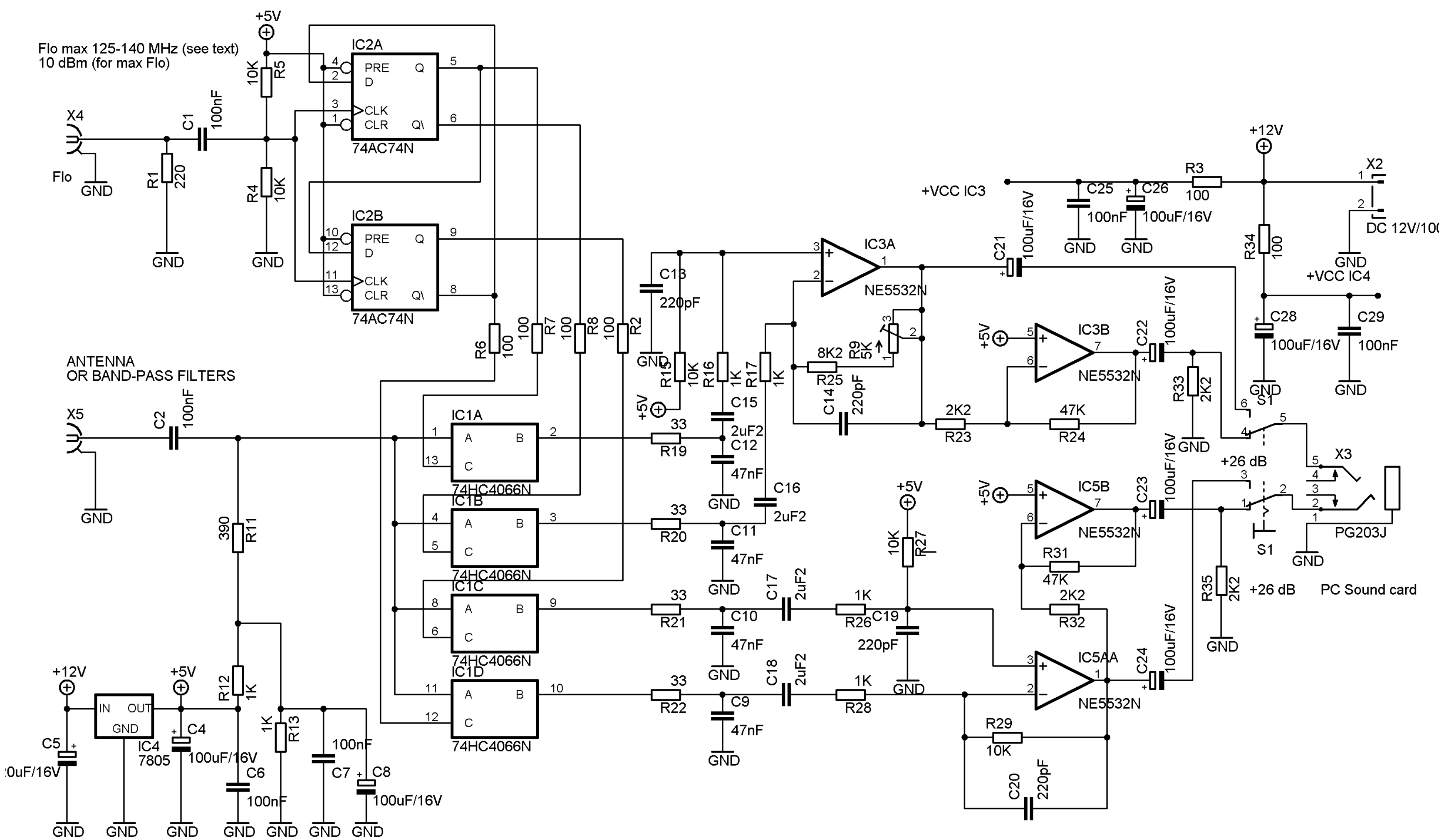
Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

Many HAMs all over the world built my SDR S/H receivers DR1, DR2, DR2A, DR1A… . You can see some photos on my sites and I can emphasize that they are all satisfied with results .Simple constructions with cheap classic components are working really very well. All SDR receiver designs have some positive and some negative aspects of design. The SDR receiver DR2 with I/Q outputs which I had been published first , it is mine the most popular design. I received a lot positive comments all over the world and I read many positive impressions on forums. Two things returned me back to this design.

1. I wrote that is possible to build extra simple receiver with outstanding performances without any coils. I noticed that this statement was without any comments. Many homebrew builders are still suspicious in my realizations that it is possible make receiver without any input filters and coils. This fact was really unbelievable for most builders who try to make any kind of receiver. They know that these facts mean a lot IMD products and really "mix" unwanted broadcast signals at the receiver output. I received pictures of my realizations with input band pass filters for any case. The band pass are not necessary part except for DR2C receiver (non optimum design) and only in one situation that we must have it is multi-multi operation in very close neighborhoods. This kind operation can damage receivers with excessive input power and lead to the IMD products at receiver outputs (mainly cased by the OP AMP clipping). I wrote about this situation with my neighbor YU1KR in article part1.

2. I received also some negative comments about PCB. It is bigger than it is necessary and that I could make PCB better. I am not CAD PCB expert I am in that field only hobbyist. My initial intension was not to fascinate readers and builders how small and good PCB and original parts placement I that can do but to share my results with all and help them to make easier PCB. I have professional experience with design repeatability and even mass production problems. I know how hard it is making something like receivers, transmitters which can everybody repeat at home in any circumstances with parts which are not as in schematics but close values and close performances. I am sure that most number of my designs have this quality and that only errors are cased by wrong soldering could make problems that designs are not working. This article is my attempt to make situations that anybody with or without any practical experience can make receiver which will work from the first if it is soldered correctly with outstanding performances. In realizations are only resistors, capacitors and couple ICs. I will write article in future in which I will on popular way explain how my designs are working and how they are balanced and how they are achieving performances without RF parts.

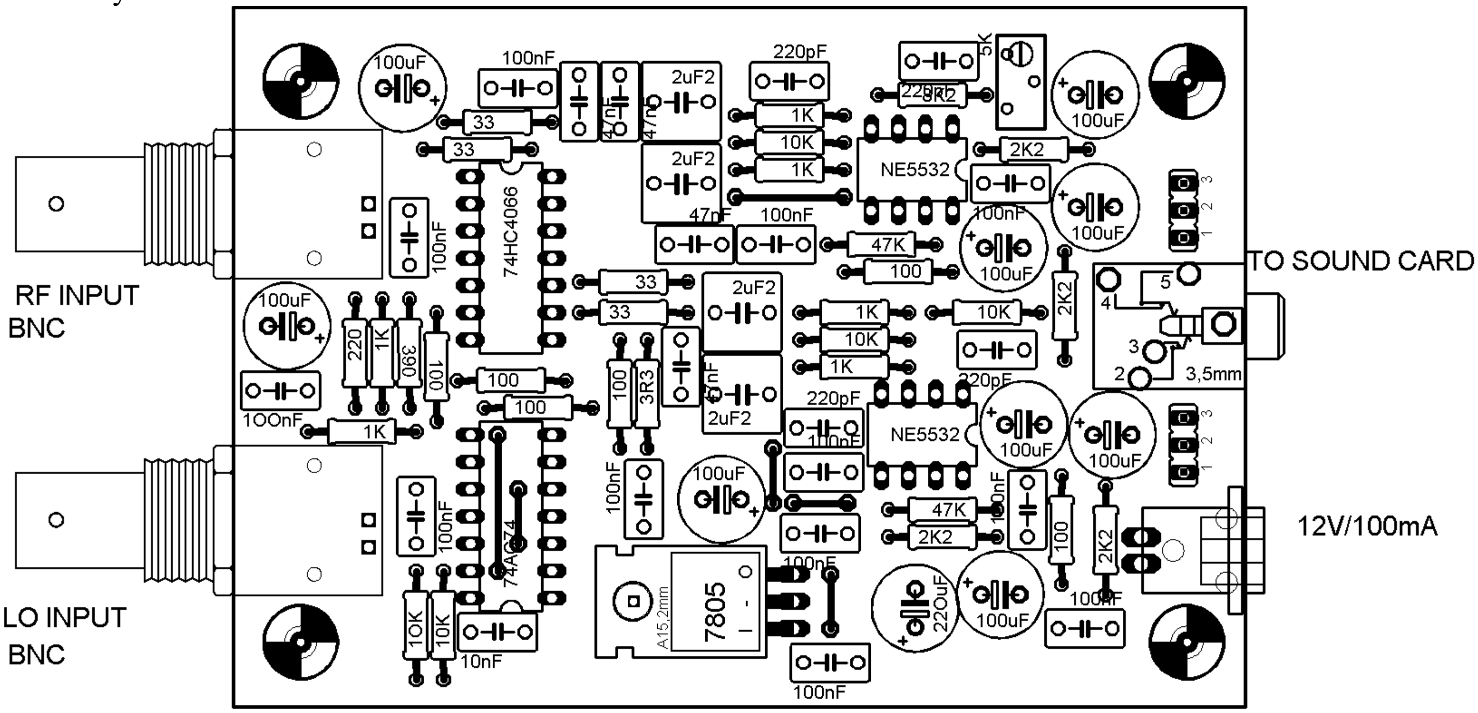
If we are talking about measured performances ,they are the same as they were for DR2 original design (see part1) except one that I lost about 1-2 dB in MDS but with better sound card like Audigy NX2 which I am using now. MDS Results are the same or few dB 1-2 even better than with Realtec AC79.

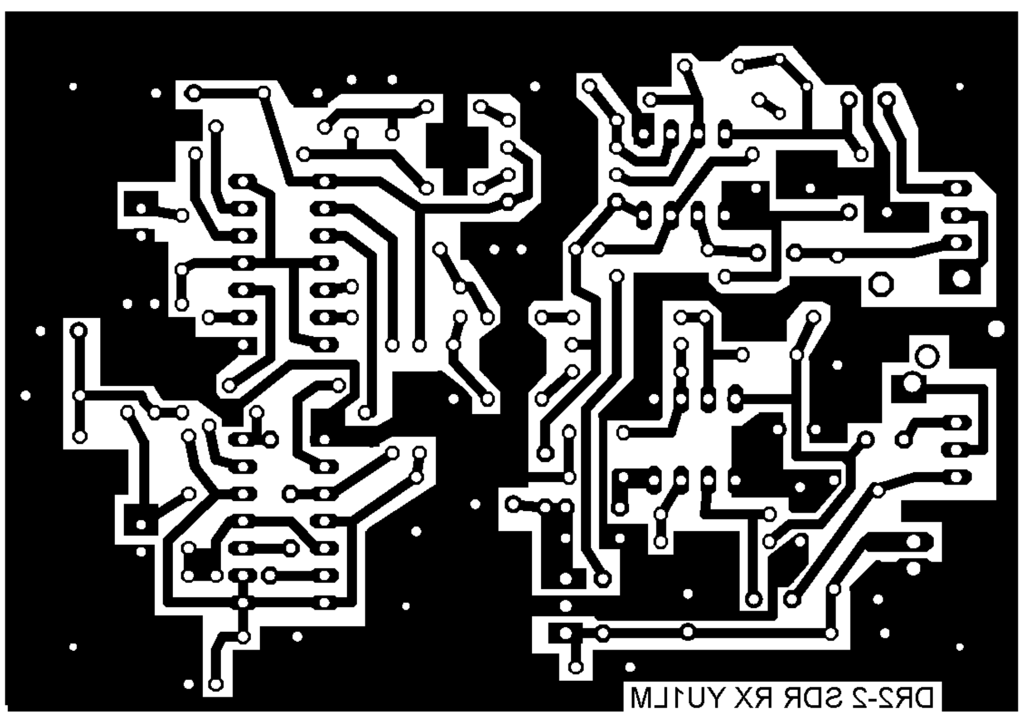


HF I/Q SDR Receiver without coils DR2-2

30 kHz-40 MHz YU1LM/QRP

I made some simplifications in schematic but basically design is the same except that is without any coils.





DR2-2 single side PCB dimensions 95 x 65 mm (original DR2 dimensions are 105 x 80 mm)

I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

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HF SDR S/H Sample and Hold Receiver DR2E (Modification of DR2 with new Audio Instrumental Amplifiers) from 30 KHz to 35 MHz-Make it Simple as Possible with Outstanding Performances

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

I read a lot of comments related to my SDR designs. I must admit that some comments were OK. One of these was that my post S/H detectors amplifiers are not optimal designs, comments from Vytas LY3BG at SDR forum ref 3. If you read article from Gerald AC5OG you will realized that for the HF even to 50 MHz receiver NF (noise figure) is not so important performances like dynamic range. Of course it is very nice if it is possible to achieve all in one design. Every design is some kind of compromise. It is very hard to fulfill all that in one design especially if it a simple as mine. I was aware situation from the beginning. The overall feedback at OP AMP also is against better NF and in all designs I have very strong negative feedback to reduce OP AMP gain. This problem and how to solve it I will explain in the SDR RXs for VHF and UHF bands. In short, solution is using of instrumental audio OP AMP connection. AC5OG Gerald is using in his famous SDR1000 transceiver this way. Very good instrumental OP AMP is laser trimmed for good CMRR like INA163….and it is not so cheap. I made this kind of instrumental OP AMP with 3 OP AMP from NE5532 (for VHF and UHF bands I am using better OP AMP very expensive "state of the art" AD797).

Practically I pasted DR2 input circuit S/H detector to the audio instrumental OP AMP realization with NE5532 used in SDR AR1, AR2 VHF and UHF receivers with 6 wires. The results ware as I had been expecting from this kind of circuit. The benefits are:

1. Better MDS , according to the my calculation must be 5 dB better. Practically I achieved 3 dB improvements results are very sensitive to the setting in SDR software.
2. Better CMRR(common mode ripple rejection- rejection in phase signals at OP AMP inputs), 30-40 dB was typical values for ordinary DR2 now it is in the case DR2E between 40-50 dB.

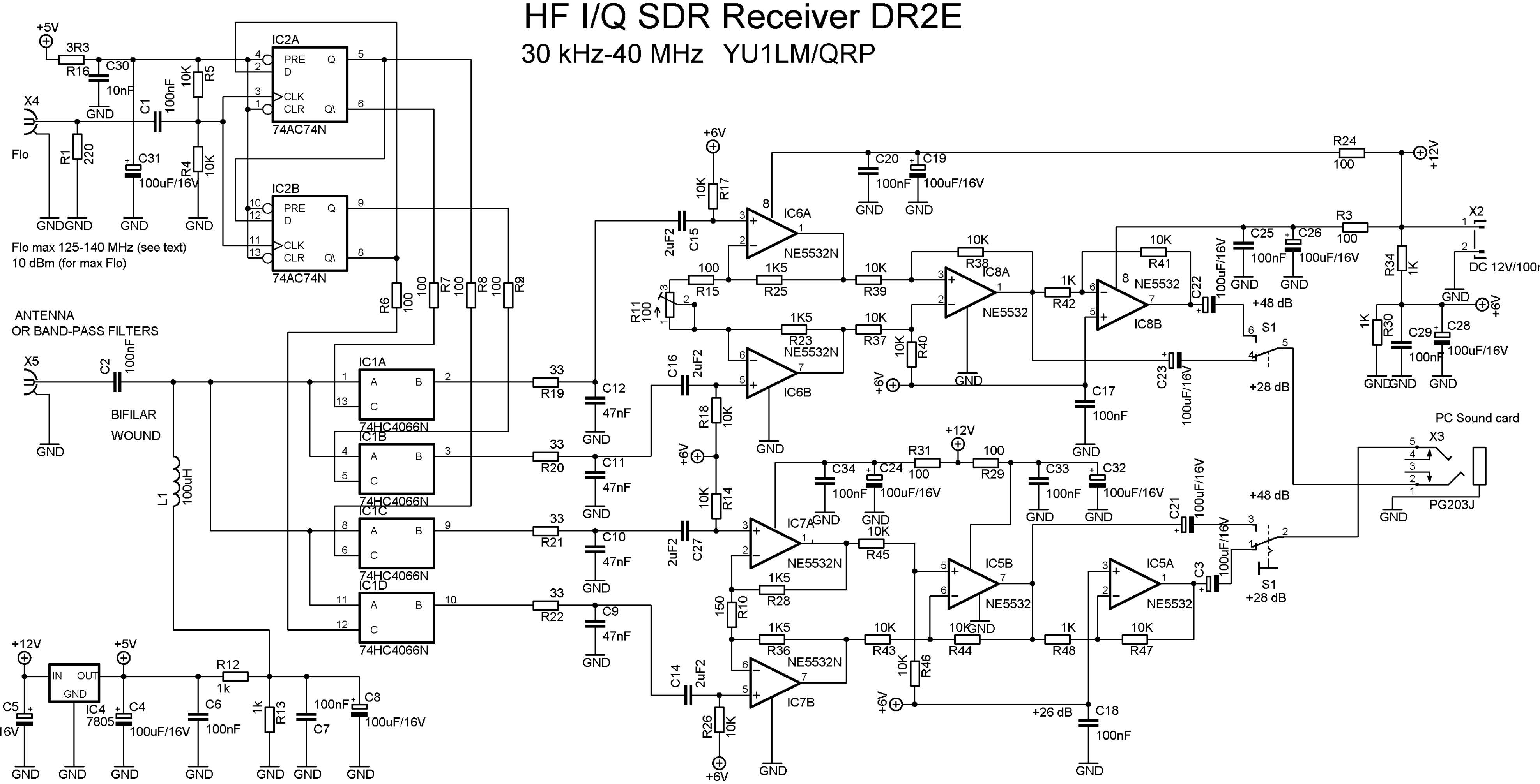
Positive side of this design has negative side too. Negative aspects are more hardware and circuit is not simple as previously.

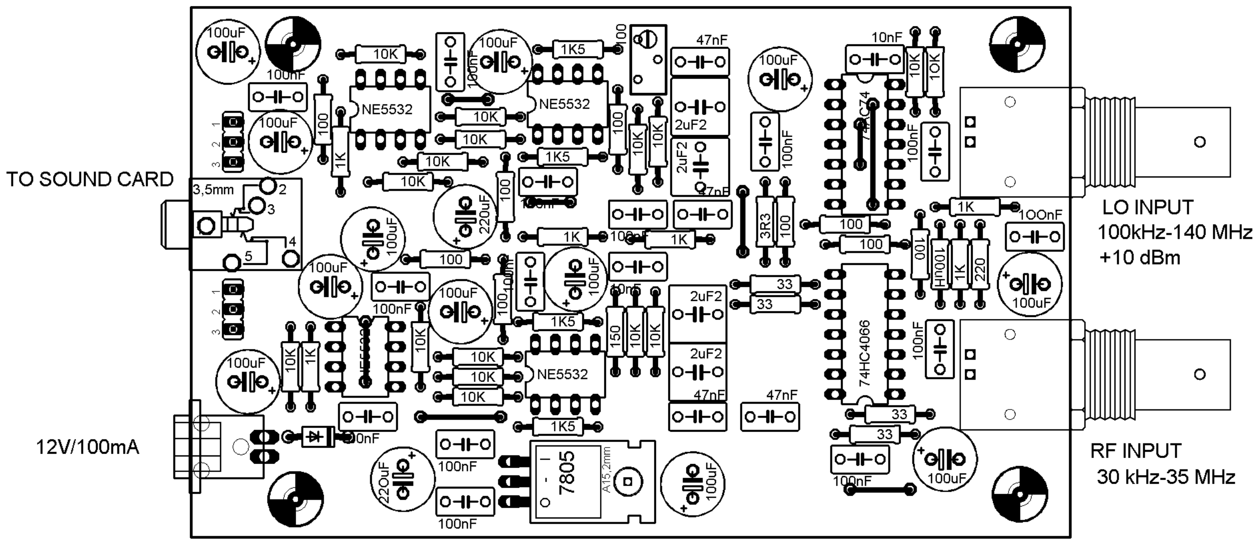
All other specifications are the same as they ware for DR2 only DR2E has 1-2 DR (dynamic range) improvement and optimal virtual ground Vcc/2 at +6 V for OP AMPs to use full possible output voltage swing 10Vp-p. We can obtain 1 dB in DR more with power supply VCC +15 V !!

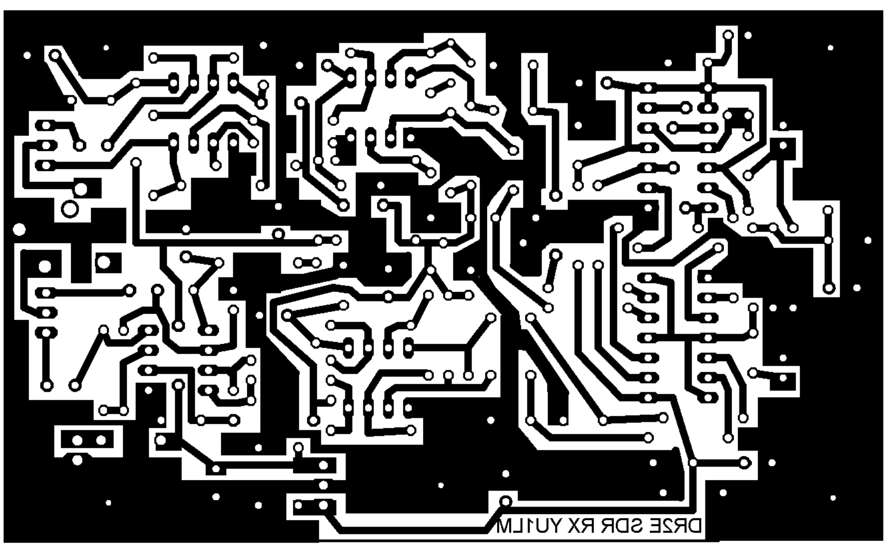
I didn't make this DR2E PCB yet but I tested this circuits and I don't expecting any problem because circuit DR2E with wire connections was working very well.

HF I/Q SDR Receiver DR2E

30 kHz-40 MHz YU1LM/QRP







DR2E single side PCB dimensions 112 x 68 mm

I made great effort to make SDR projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

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4. ***http://translate.google.com/translate?hl=en&sl=ru&u=http://forum.cqham.ru/viewtopic.php%3Fp%3D105931&sa=X&oi=translate&resnum=10&ct=result&prev=/search%3Fq%3Dyu1lm%2Bsdr%26start%3D10%26hl%3Den%26lr%3D%26sa%3DN***
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Band Pass Filter with Low Insertion Loss for 2m

Dipl ing Tasić Siniša –Tasa YU1LM/QRP

This design is part of my VHF/UHF SDR receivers. The VHF /UHF receivers are assembled as “RF bricks”. The receiver is broad band design and determined with used mixer. Input filter and local oscillator are determining receiving band. In some causes I am using preamplifier to improve receiver sensitivity also. This band pass filter is one of this bricks. It is input filter for 2 m. It is very easily repetitive design but it is now realized with C SMT components. I didn’t try classic C size components but from some mine previously designs experience it is possible realization. One way is that capacitors are mounted from the ground (bottom) side. We can drill PCB for capacitors mounting and than capacitors leads solder from the top side. To prevent unwanted contacts with GND first we will drill PCB with borer smaller size for example 0.8 or 1 mm and than with borer 2.5-3 mm on the bottom GND side to remove copper surface only. The double side of PCB can be make as it is proposed with soldering the rest of resistor leads through the holes drilled between top and bottom PCB side. This is easy way how to make home made metallization of vias. I am recommending you that filter are mounting inside the some metal box or box made from soldered FR4 double side peaces.

Filter is mounted at the front of the mine 2 m SDR receiver. Double balanced diode mixers are very sensitive to the very big number broad band input signals and harmonic receiving. The input band pass filter is improving IMD specification from receiver. The 2 meter receiver can be easily overload with out-band signals. The realized filter had moderate selectivity; FM and TV band are attenuated min 40 dB.

I wish you successfully 2 m band pass filter realization.

VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP

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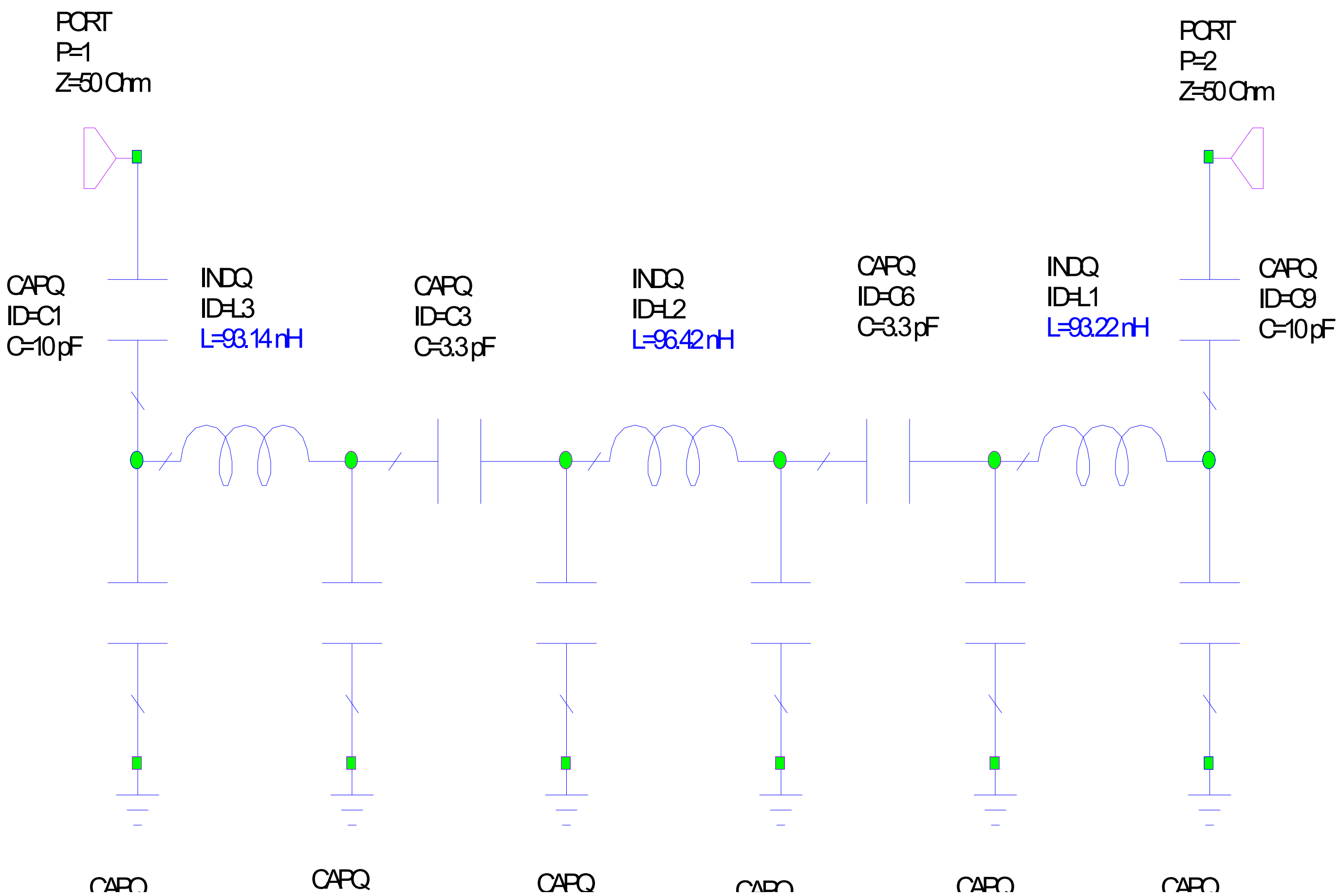
PORT
P=1
Z=50 Ohm
PORT
P=2
Z=50 Ohm
CAPQ
ID=C1
C=10 pF
INDQ
ID=L3
L=93.14 nH
CAPQ
ID=C3
C=3.3 pF
INDQ
ID=L2
L=96.42 nH
CAPQ
ID=C6
C=3.3 pF
INDQ
ID=L1
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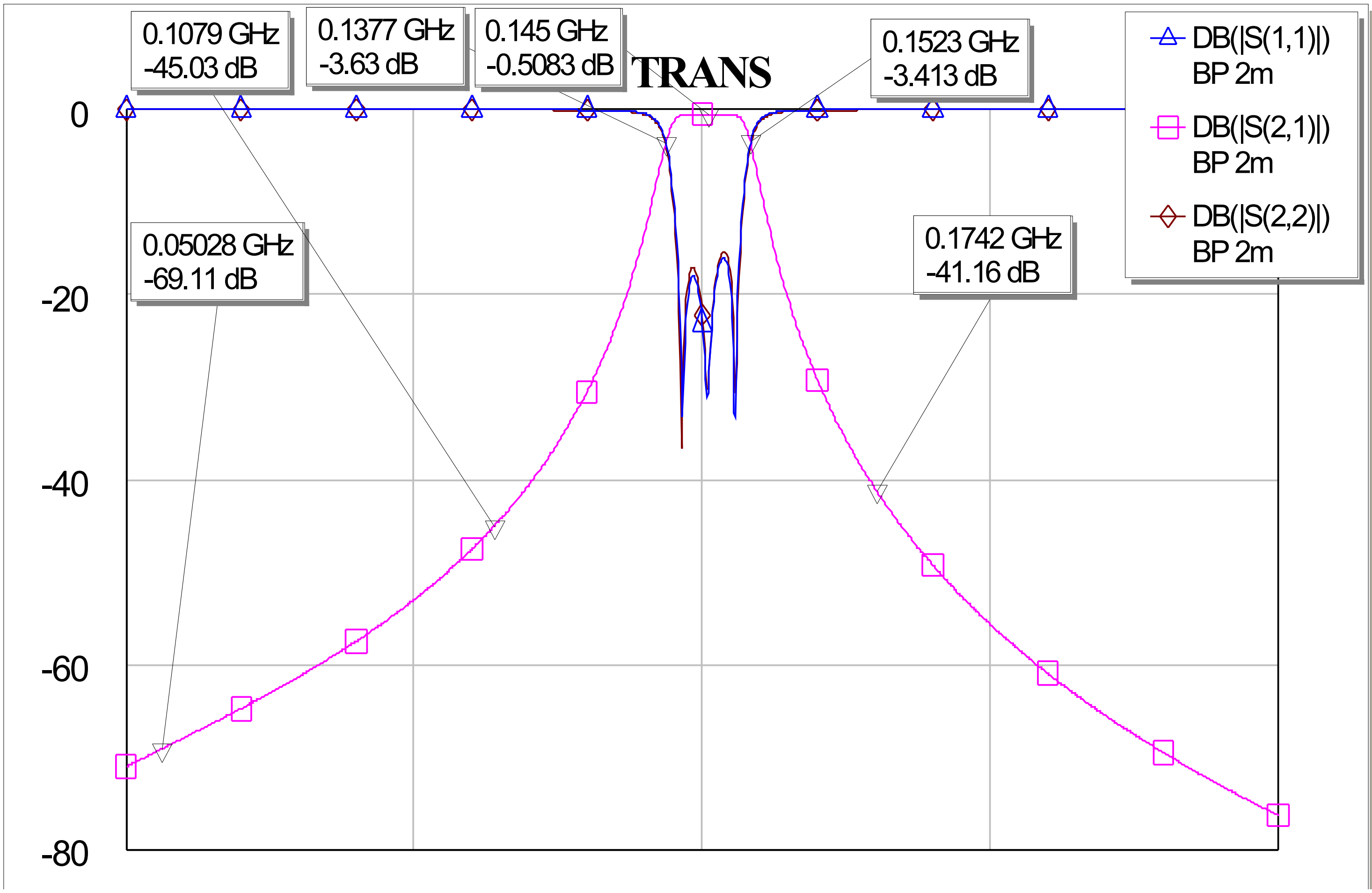
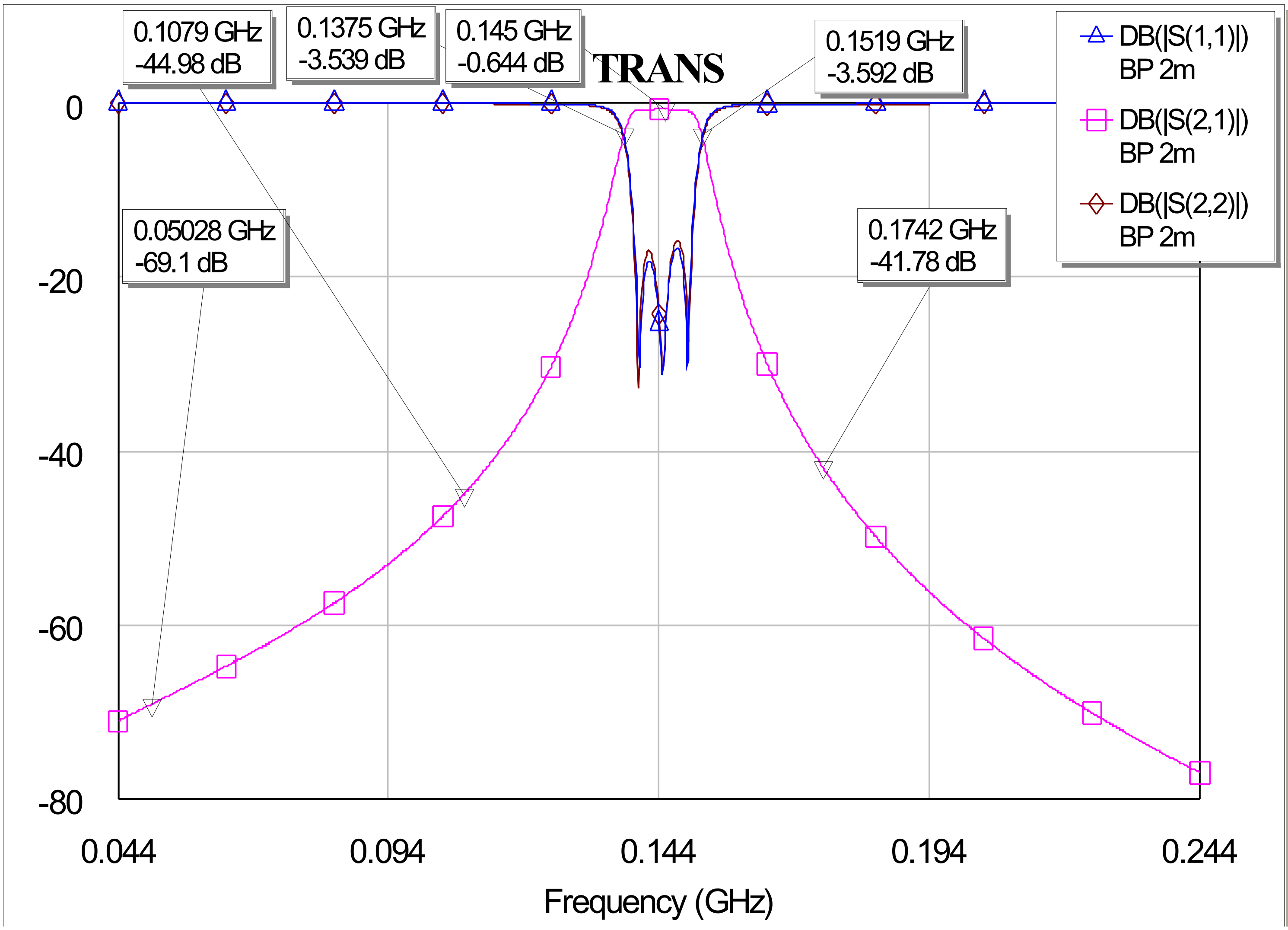
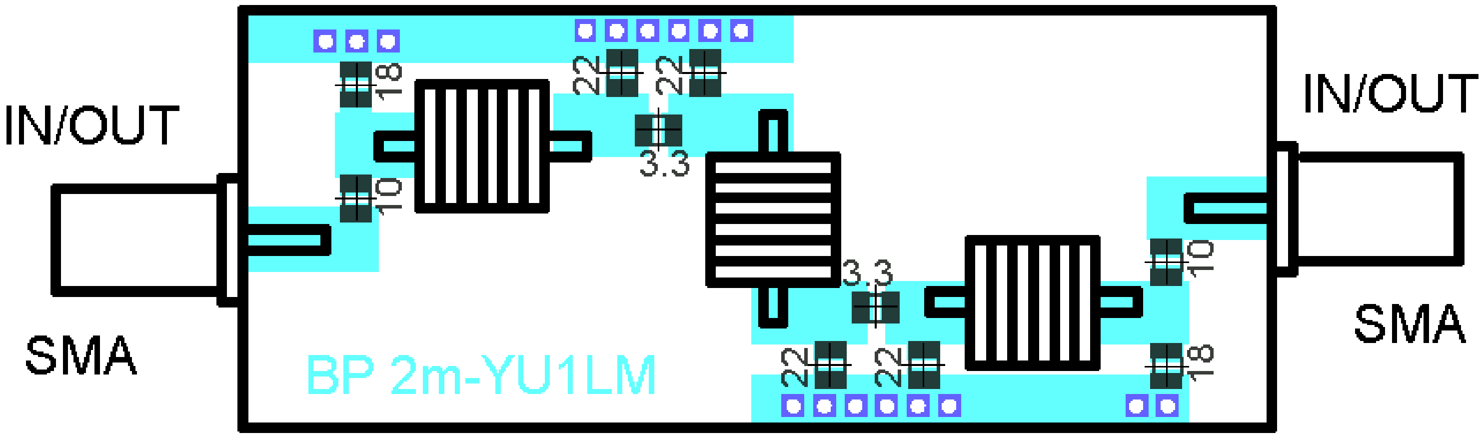


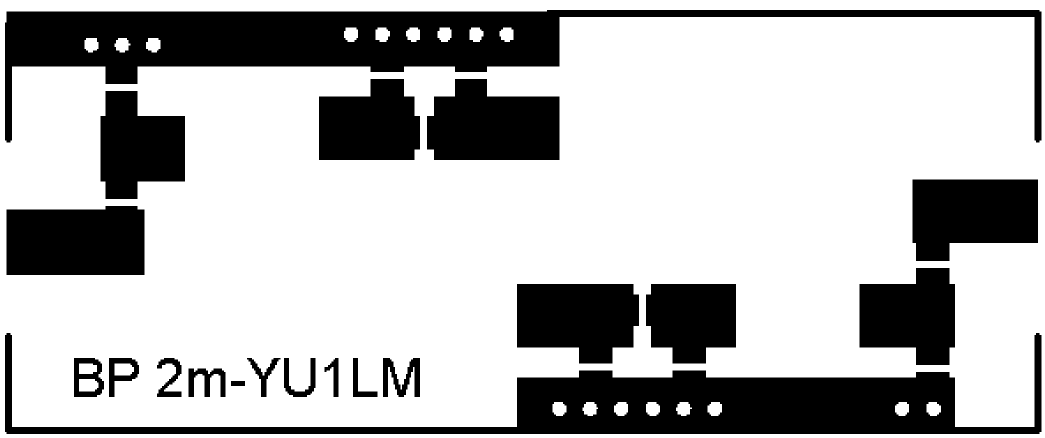
Amplitude frequency response for ideal C capacitors and real Q inductors



Amplitude frequency response for real C capacitors from Murata and real Q inductors

L= self support isolated copper wire diameter 1mm (AVG18) wound at 5 mm 6 turn close wound length 6mm Qo=350 and Frez=901 MHz.





Double side PCB (bottom side is completely copper side) dimension 50 x 20 mm

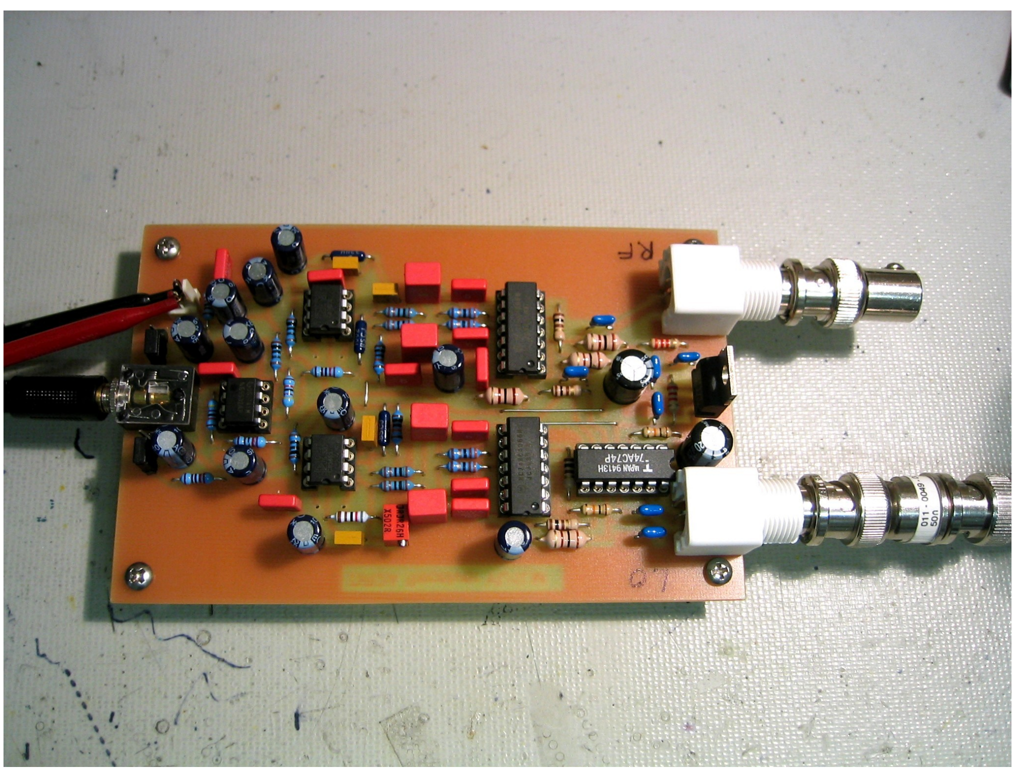
DR2A S/H HF SDR Receiver Additional Measurements

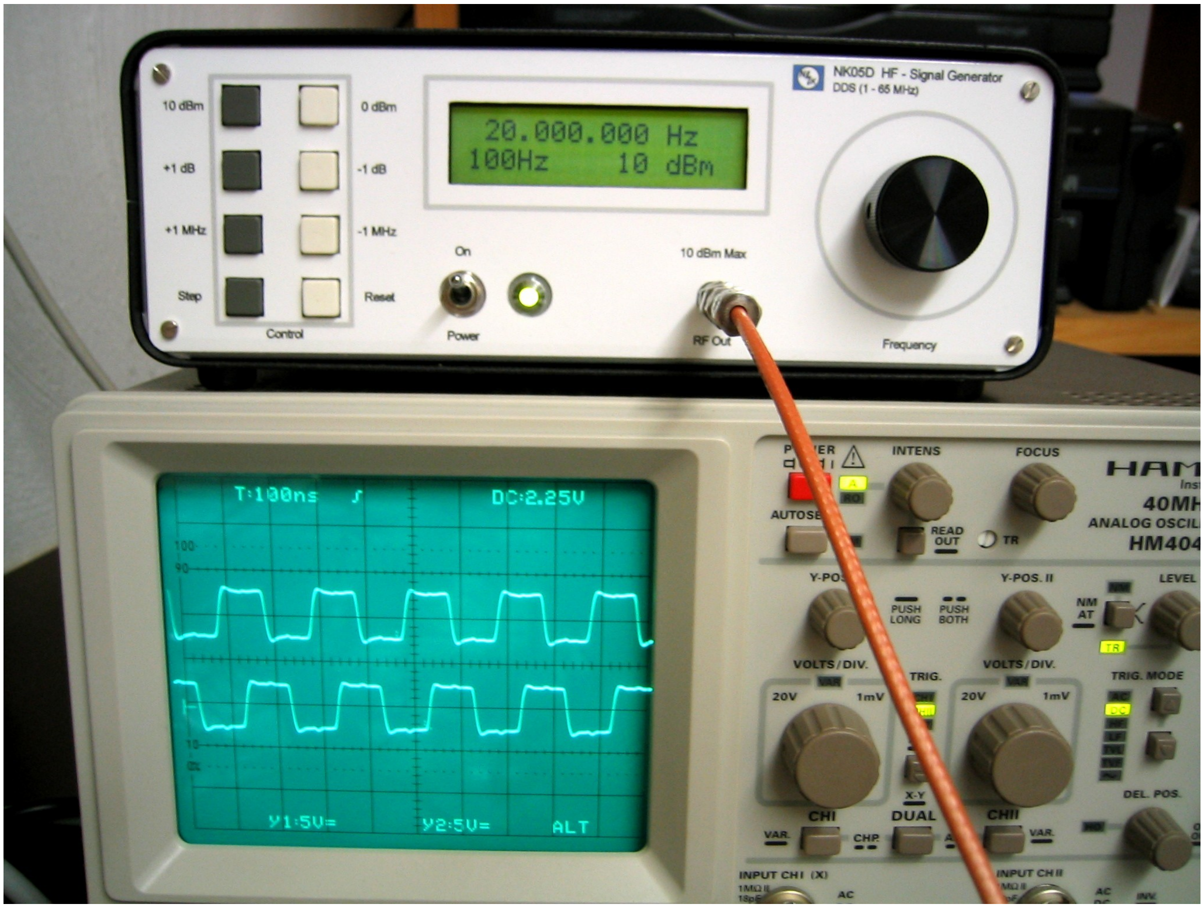
Dipl. Ing Tasić Siniša-Tasa YU1LM/QRP & Norbert Kohns DG1KPN

I received a lot messages about my SDR designs from HAM and non HAM SDR fans all over the world. Some messages, except performances comments and error detection, was very interesting for me like message which I received from Norbert DK1KPN. We exchange few messages and this article is results of this conversation and Norbert's wish to measure some DR2A performances which I didn't make. I want to thank you Norbert to his big effort and very nice measuring diagrams.

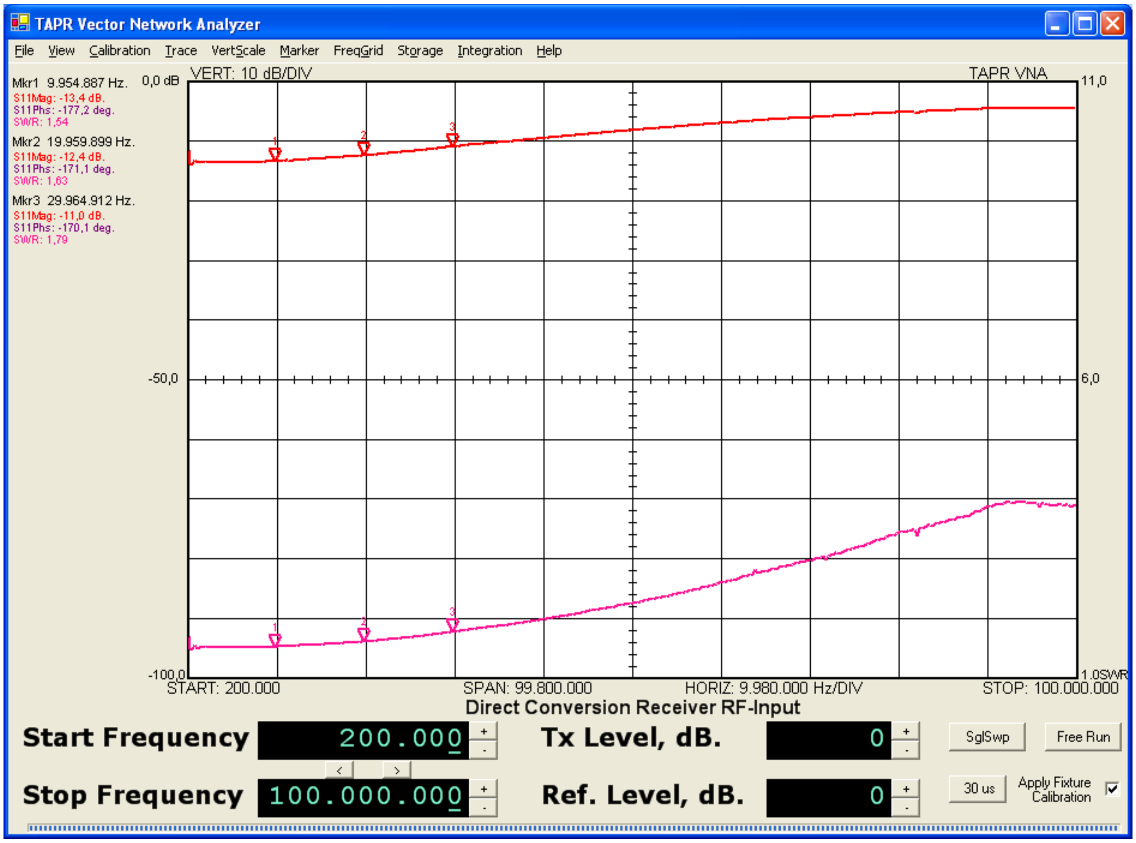
I meantime I made some limited quantity of DR2A PCBs and I assembled few DR2A samples with new PCB also .I made measurements on them to see how receiver performances are spreading. Now for SDR PC processing I used better 24 bit SB USB sound card Audigy NX. The biggest performances improvement was in MDS. MDS (minimal detectable signal) was between -109 to -111 dBm . There is no change in the IIP3 which was around +33 to +35 dBm and result it is component built in related. DR2A have the biggest IIP3 and SFDR (spurious free dynamic range) from all my SDR designs. I measure 1 dB compression point also. 1 dB compression point was between -1dBm to +1 dBm (S9 +68 dB !!!) at the lower AF gain position and for +5 V Vcc power supply for 74 HC4066 IC. Limitation wasn't S/H detector but OP AMP output swing 8 V peak-peak before it is going to the clipping. S/H detector limitation is around +15-+17 dBm !!! If we are using +6 V power supply for the 74HC4066 IC than we have 2 dB 1 dB compression point improvement and OP AMP output swing is now 10V peak-peak. Higher power supply also increase F max for 74AC74 IC LO S/H driver to min 140 MHz min. +6V Power supply decrease ON resistance in 74HC4066 switches and overall improvement in SFRD is about 1-2 dB. In the high AF position 1 dB compression point was between -26 to -28 dBm. Changing input OP AMP OP027 with lowest noise "state of the art" OP AMP AD797 didn't give MDS improvements as I expected. Reading some articles about this problem I realized that it is necessary to obtain this benefit that the first OP AMP must have min +50 dB or more. This is not possible because overall SFDR have to be ruined or it is necessary to have input AGC attenuator and control for it.

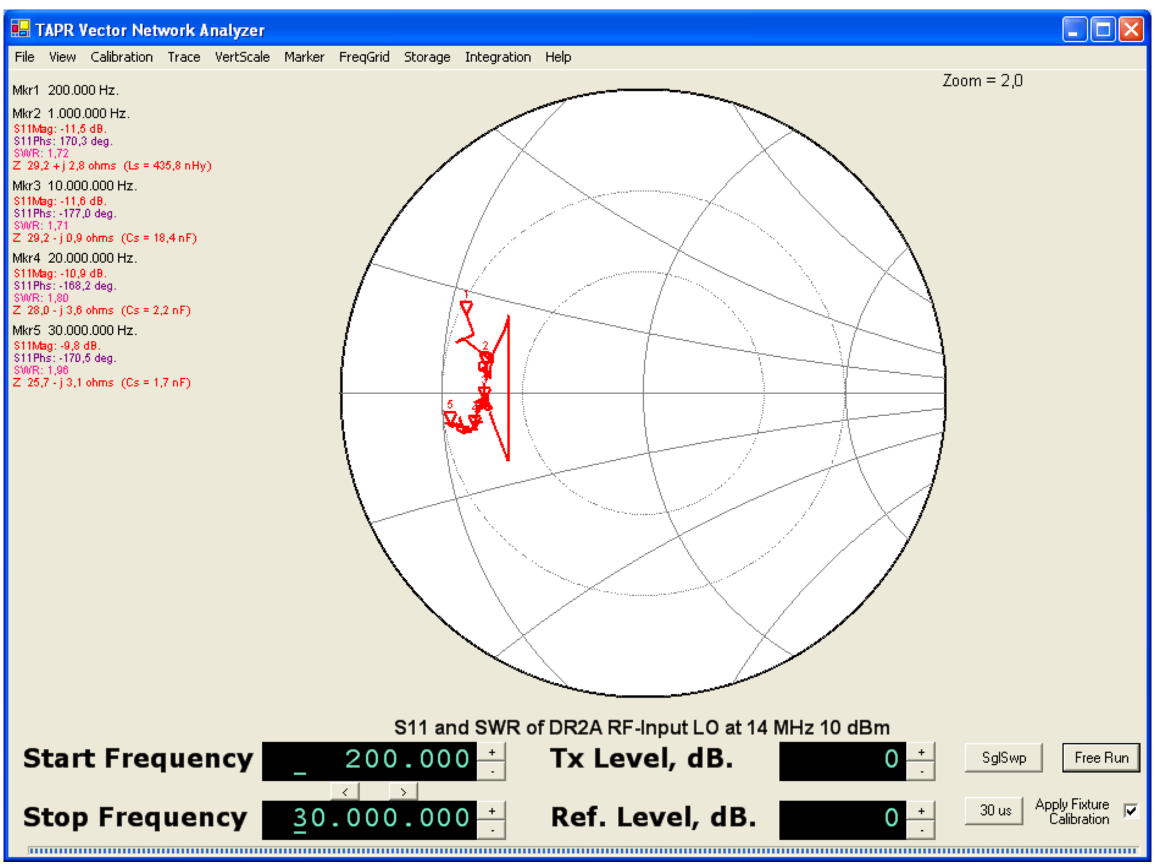
Now down they are Norbert's measuring diagrams and some my comments on them. First it is picture of Norbert DR2A realization and second how LO I/Q signal driving S/H detector looks like.



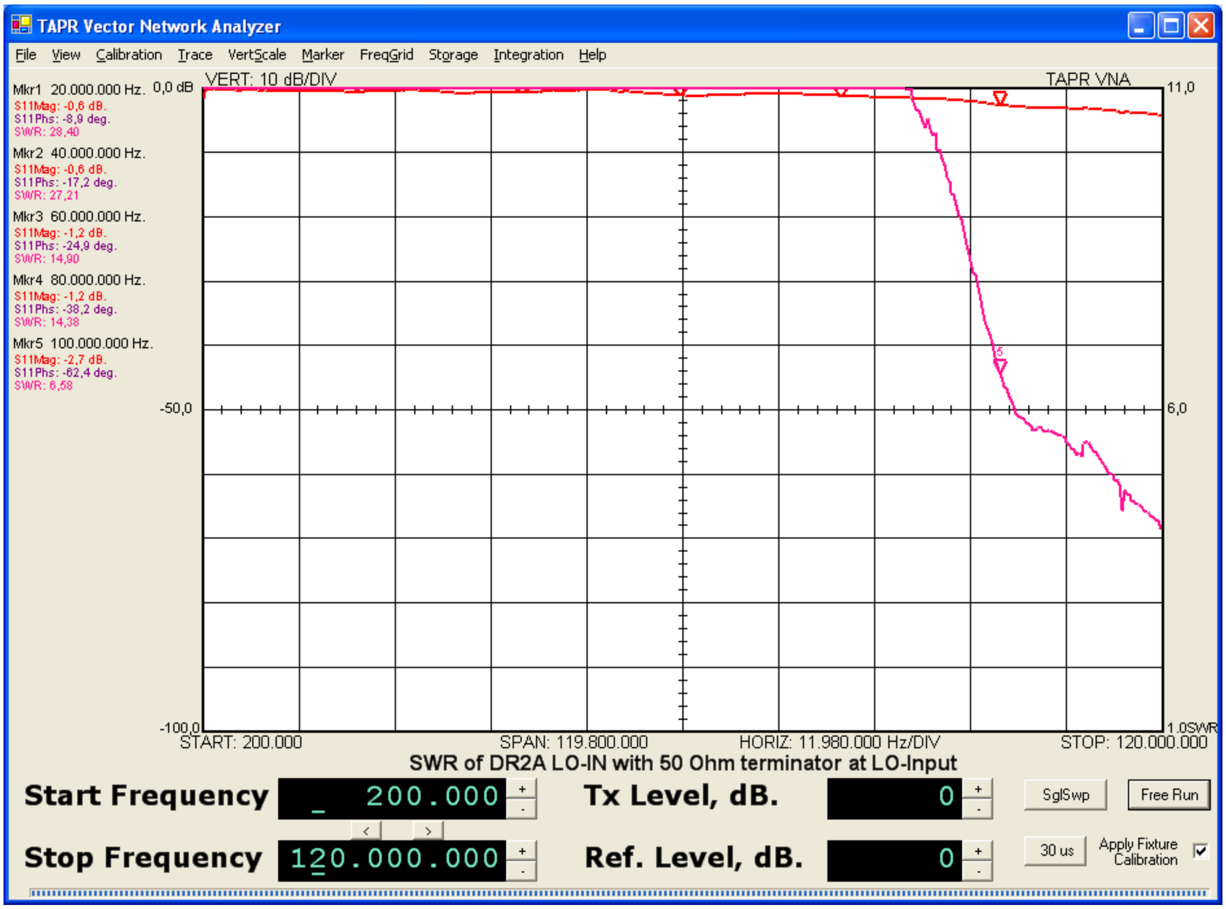


I didn't measure input VSWR for the DR2A receiver. According to the mine calculation it has to be around S11=-15 db. Measured result is very close to this value at lower frequencies and I am satisfied with relative good prediction. As I explained in previously published articles this results are very sensitive to the IC manufacturer because this 74HC 4…. series are not last and modern technology products.

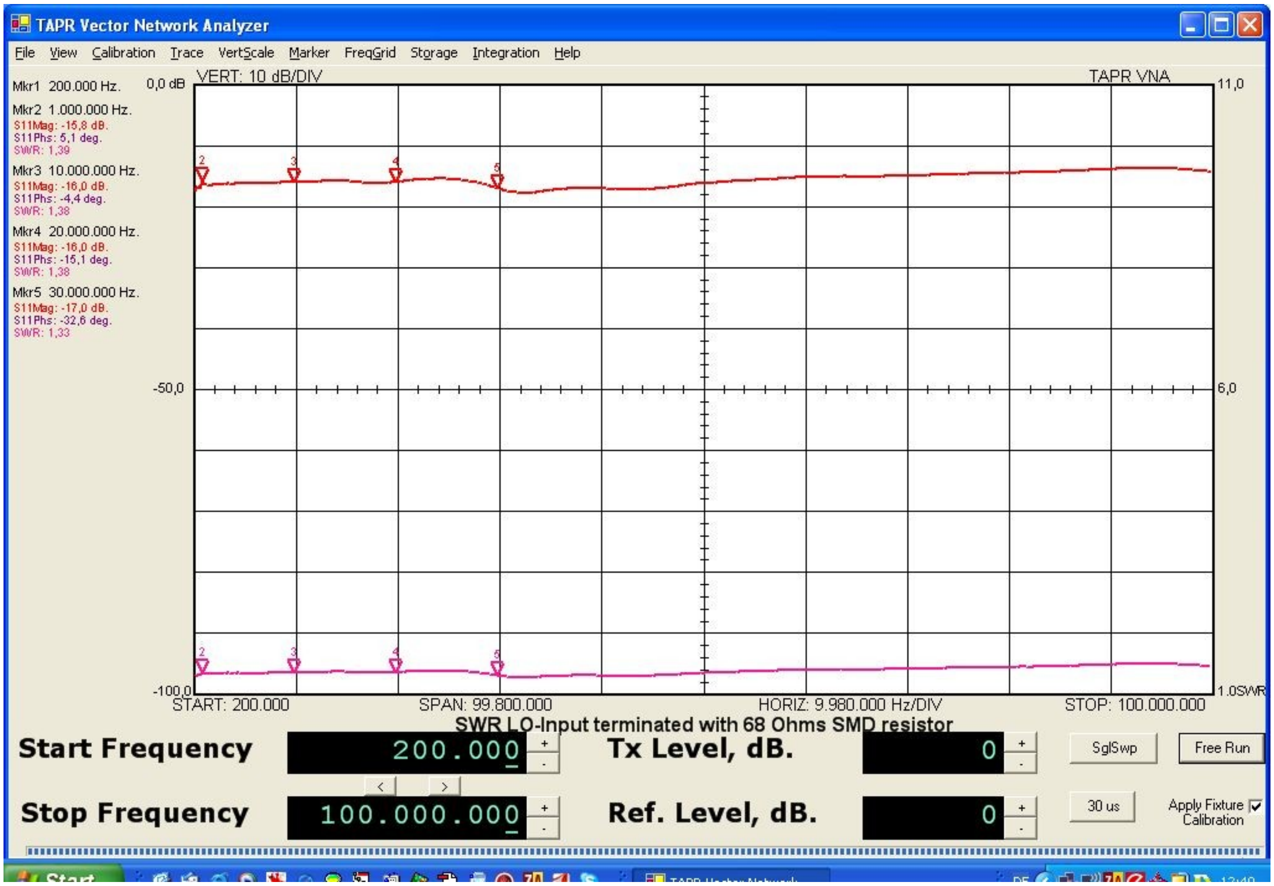

TAPR Vector Network Analyzer
File View Calibration Trace VertScale Marker FreqGrid Storage Integration Help
Mkr1 9.954.887 Hz.
S11Mag: -13,4 dB.
S11Phs: -177,2 deg.
SWR: 1,54
Mkr2 19.959.899 Hz.
S11Mag: -12,4 dB.
S11Phs: -171,1 deg.
SWR: 1,63
Mkr3 29.964.912 Hz.
S11Mag: -11,0 dB.
S11Phs: -170,1 deg.
SWR: 1,79
0,0 dB
VERT: 10 dB/DIV
TAPR VNA
11,0
-50,0
6,0
-100,0
1.0SWR
START: 200.000
SPAN: 99.800.000
HORIZ: 9.980.000 Hz/DIV
STOP: 100.000.000
Direct Conversion Receiver RF-Input
Start Frequency
200.000
Tx Level, dB.
0
SglSwp
Free Run
Stop Frequency
100.000.000
Ref. Level, dB.
0
30 us
Apply Fixture Calibration


TAPR Vector Network Analyzer
File View Calibration Trace VertScale Marker FreqGrid Storage Integration Help
Zoom = 2,0
Mkr1 200.000 Hz.
Mkr2 1.000.000 Hz.
S11Mag: -11,5 dB.
S11Phs: 170,3 deg.
SWR: 1,72
Z 29,2 + j 2,8 ohms (Ls = 435,8 nHy)
Mkr3 10.000.000 Hz.
S11Mag: -11,6 dB.
S11Phs: -177,0 deg.
SWR: 1,71
Z 29,2 - j 0,9 ohms (Cs = 18,4 nF)
Mkr4 20.000.000 Hz.
S11Mag: -10,9 dB.
S11Phs: -168,2 deg.
SWR: 1,80
Z 28,0 - j 3,6 ohms (Cs = 2,2 nF)
Mkr5 30.000.000 Hz.
S11Mag: -9,8 dB.
S11Phs: -170,5 deg.
SWR: 1,96
Z 25,7 - j 3,1 ohms (Cs = 1,7 nF)
S11 and SWR of DR2A RF-Input LO at 14 MHz 10 dBm
Start Frequency
200.000
Tx Level, dB.
0
SglSwp
Free Run
Stop Frequency
30.000.000
Ref. Level, dB.
0
30 us
Apply Fixture Calibration

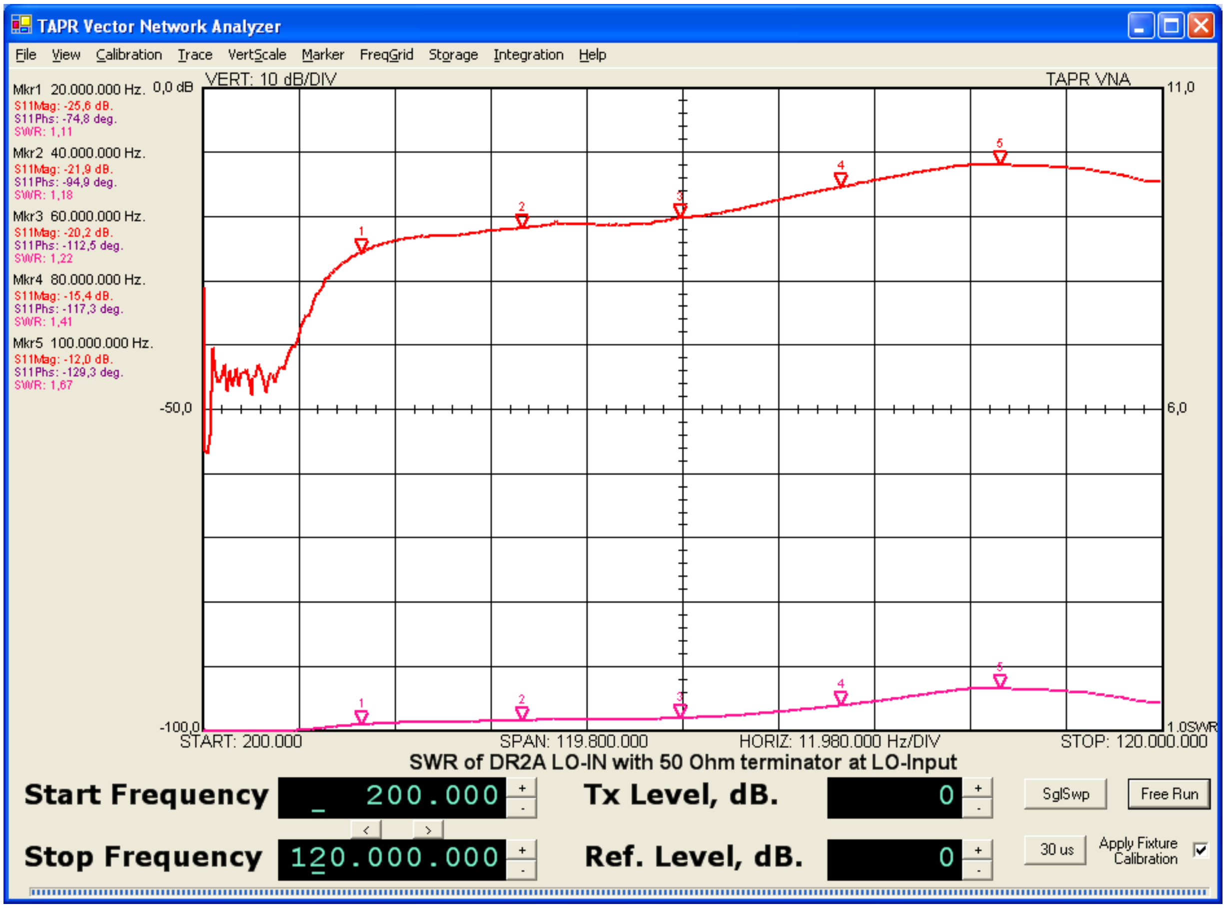
S11= -11 dB at the 29 MHz are not very good result from mine point of view but I have admit that this result is comparable with some HAM professional products. This results will not degrade input band pass filter if it is build-in at the input. Quite different situation is with LO termination. It isn't necessary that we have LO terminated because LO need only enough voltage drive (1.5-2 V peak-peak). Input impedance of LO port is around 4.7 K. Measured diagram gave good agreement



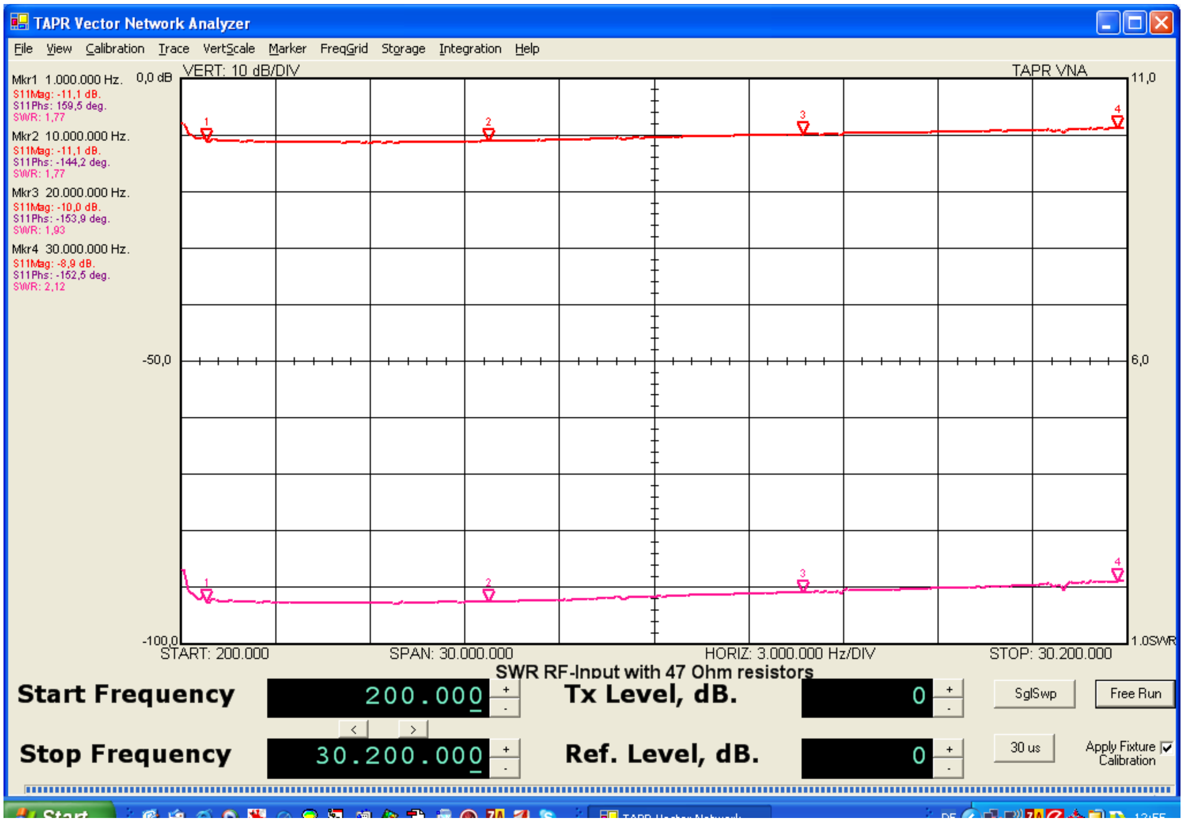
In schematics I gave solution with additional R =68 Ohms at input but this is not integral part of published PCB. Solution is possible as "piglet" from back PCB side.

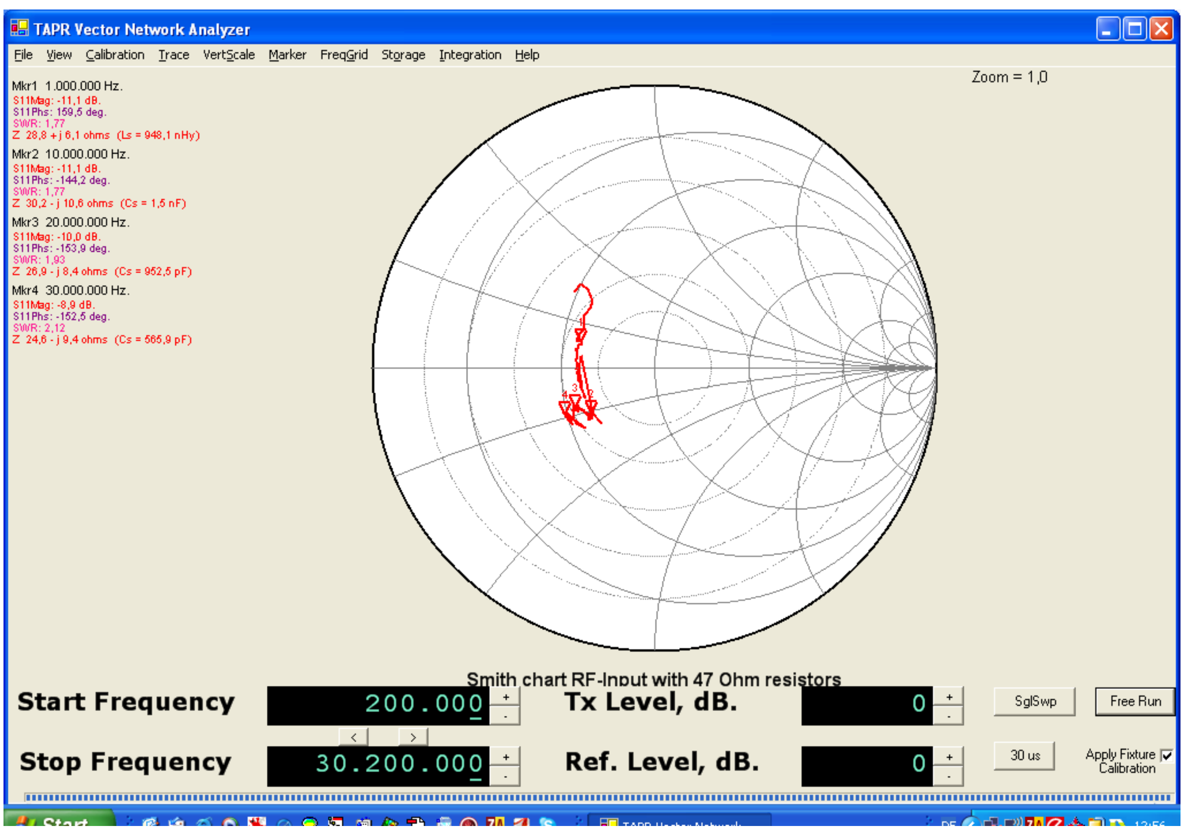


LO termination with 50 Ohms at DR2A LO input.

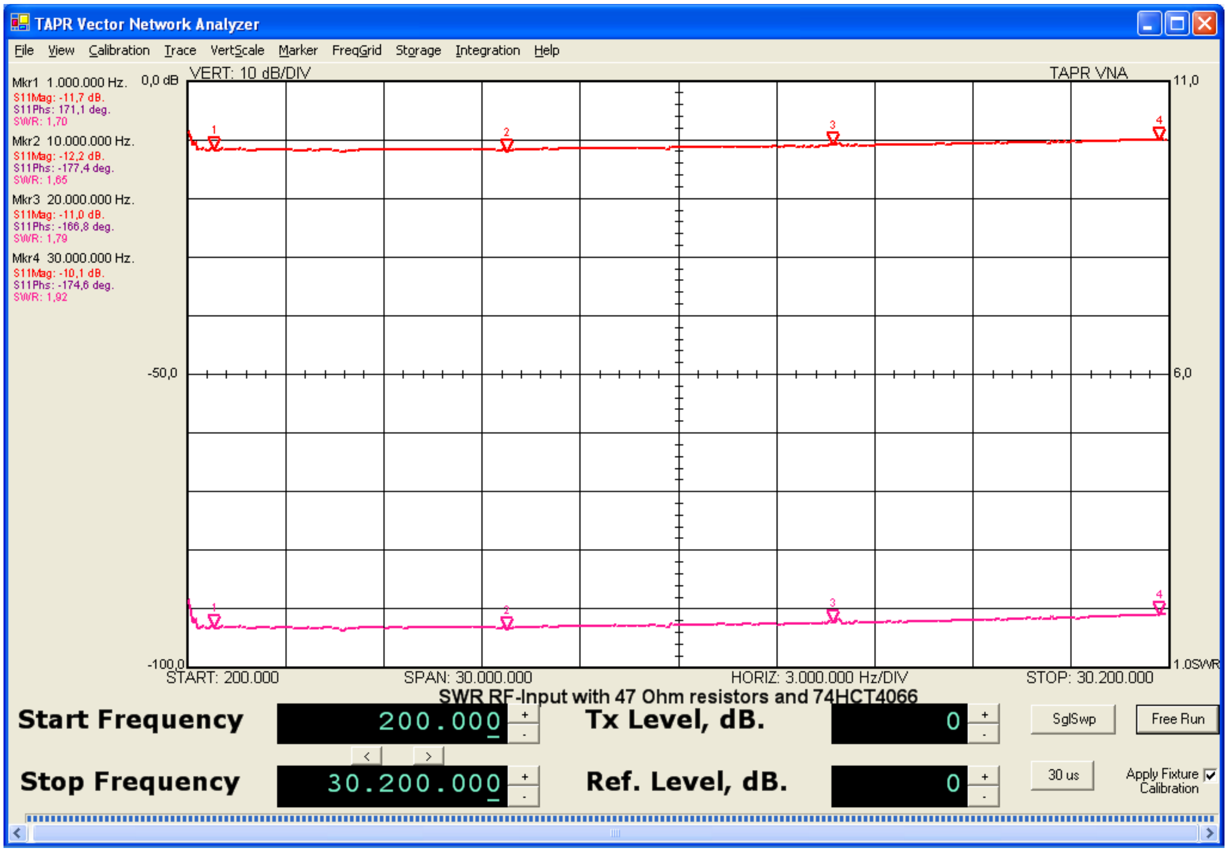


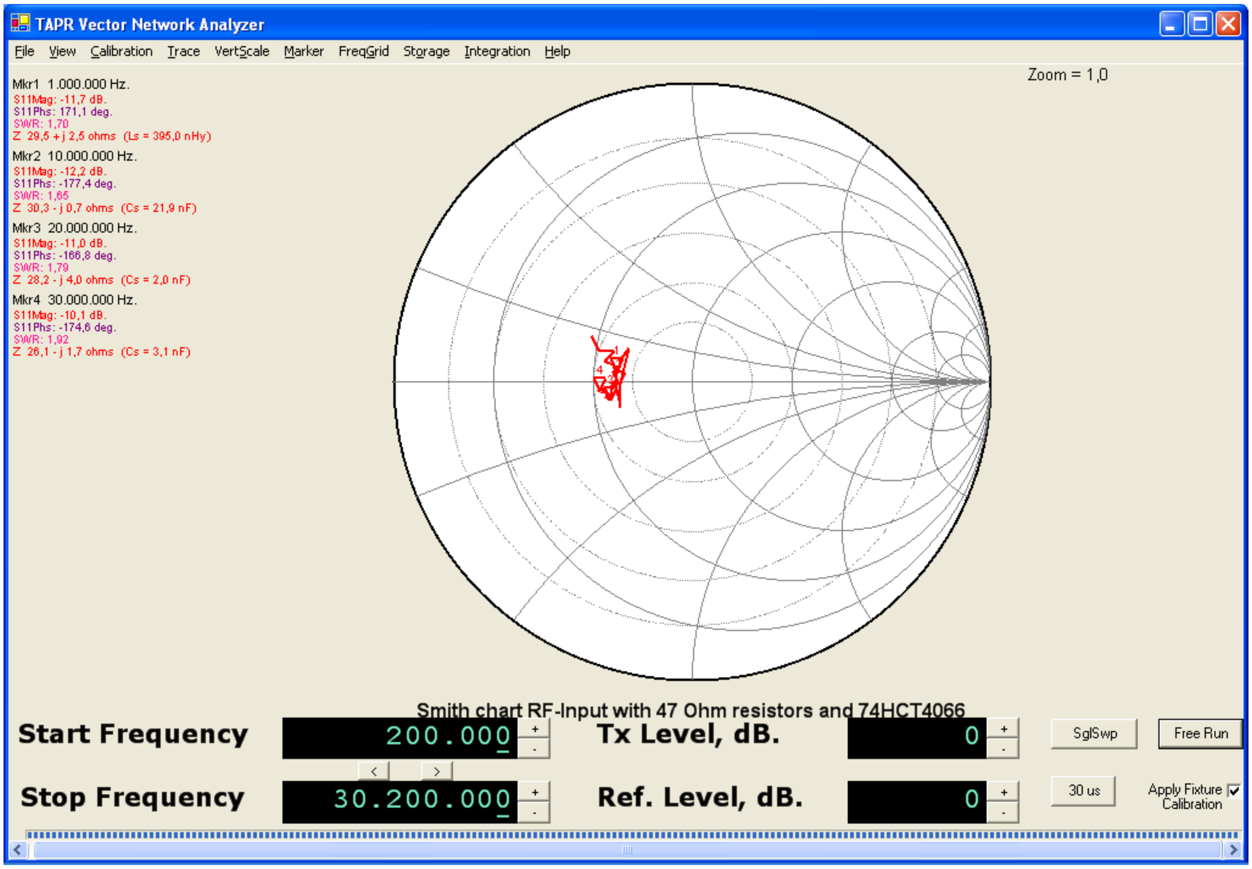
I tried to improve S11 of DR2A receiver and I suggested Norbert to change resistors 33 Ohms in S/H detector to 47 Ohms. Results are down and improvements are not evident except that we have better out of band termination.


TAPR Vector Network Analyzer
File View Calibration Trace VertScale Marker FreqGrid Storage Integration Help
Mkr1 1.000.000 Hz.
S11Mag: -11,1 dB.
S11Phs: 159,5 deg.
SWR: 1,77
Mkr2 10.000.000 Hz.
S11Mag: -11,1 dB.
S11Phs: -144,2 deg.
SWR: 1,77
Mkr3 20.000.000 Hz.
S11Mag: -10,0 dB.
S11Phs: -153,9 deg.
SWR: 1,93
Mkr4 30.000.000 Hz.
S11Mag: -8,9 dB.
S11Phs: -152,5 deg.
SWR: 2,12
0,0 dB
VERT: 10 dB/DIV
TAPR VNA
11,0
-50,0
6,0
-100,0
1.0SWR
START: 200.000
SPAN: 30.000.000
HORIZ: 3.000.000 Hz/DIV
STOP: 30.200.000
SWR RF-Input with 47 Ohm resistors
Start Frequency
200.000
Tx Level, dB.
0
SglSwp
Free Run
Stop Frequency
30.200.000
Ref. Level, dB.
0
30 us
Apply Fixture Calibration

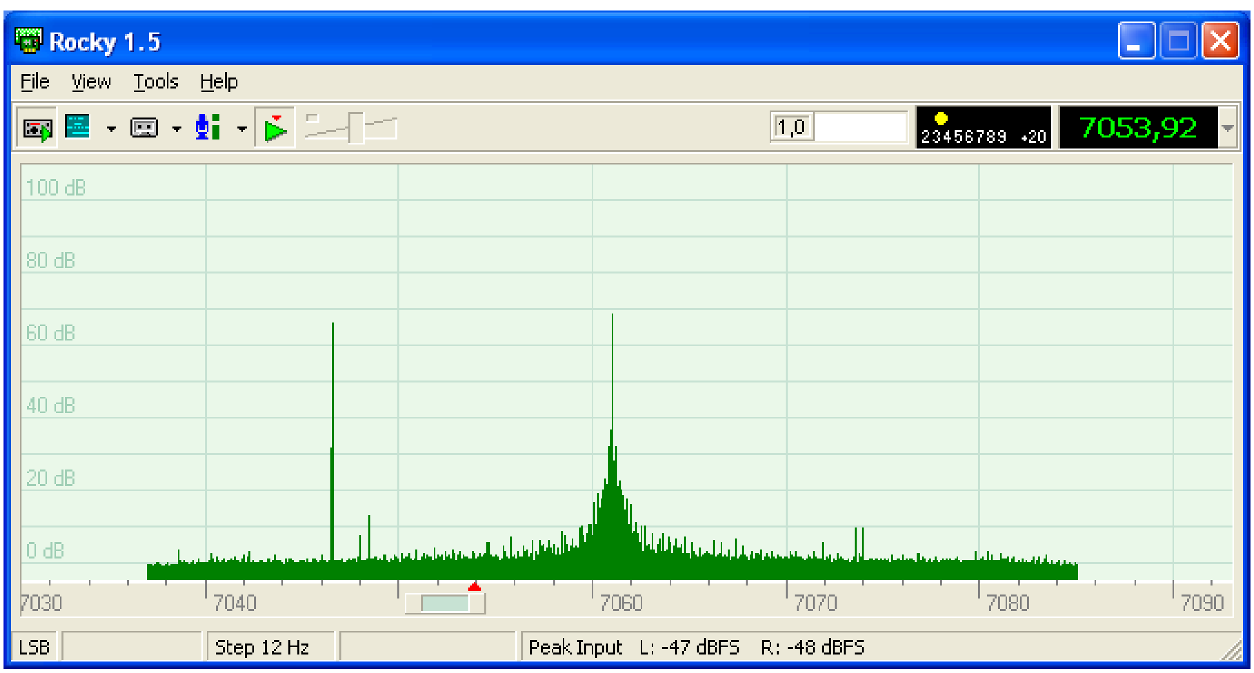

TAPR Vector Network Analyzer
File View Calibration Trace VertScale Marker FreqGrid Storage Integration Help
Zoom = 1,0
Mkr1 1.000.000 Hz.
S11Mag: -11,1 dB.
S11Phs: 159,5 deg.
SWR: 1,77
Z 28,8 + j 6,1 ohms (Ls = 948,1 nHy)
Mkr2 10.000.000 Hz.
S11Mag: -11,1 dB.
S11Phs: -144,2 deg.
SWR: 1,77
Z 30,2 - j 10,6 ohms (Cs = 1,5 nF)
Mkr3 20.000.000 Hz.
S11Mag: -10,0 dB.
S11Phs: -153,9 deg.
SWR: 1,93
Z 26,9 - j 8,4 ohms (Cs = 952,5 pF)
Mkr4 30.000.000 Hz.
S11Mag: -8,9 dB.
S11Phs: -152,5 deg.
SWR: 2,12
Z 24,6 - j 9,4 ohms (Cs = 565,9 pF)
Smith chart RF-Input with 47 Ohm resistors
Start Frequency
200.000
Tx Level, dB.
0
SglSwp
Free Run
Stop Frequency
30.200.000
Ref. Level, dB.
0
30 us
Apply Fixture Calibration

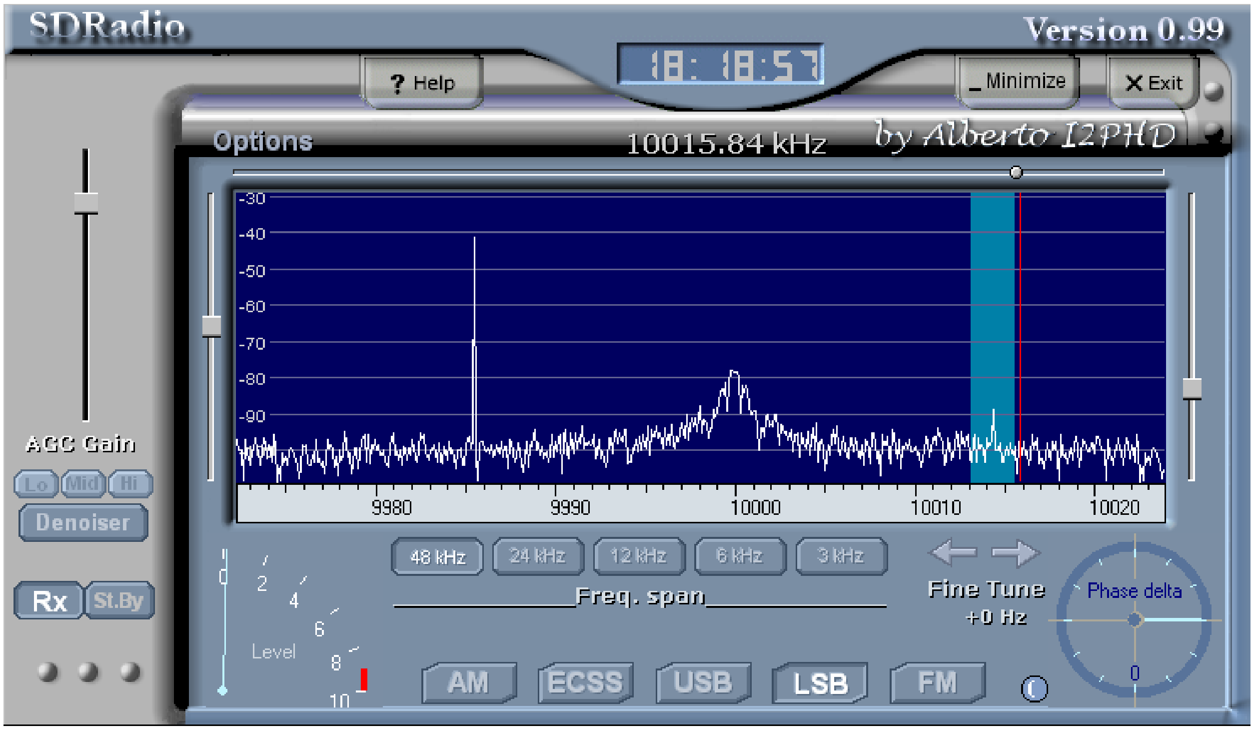
Norbert had change IC in S/H detector 74AC4066 with a 74HCT4066 and results are better

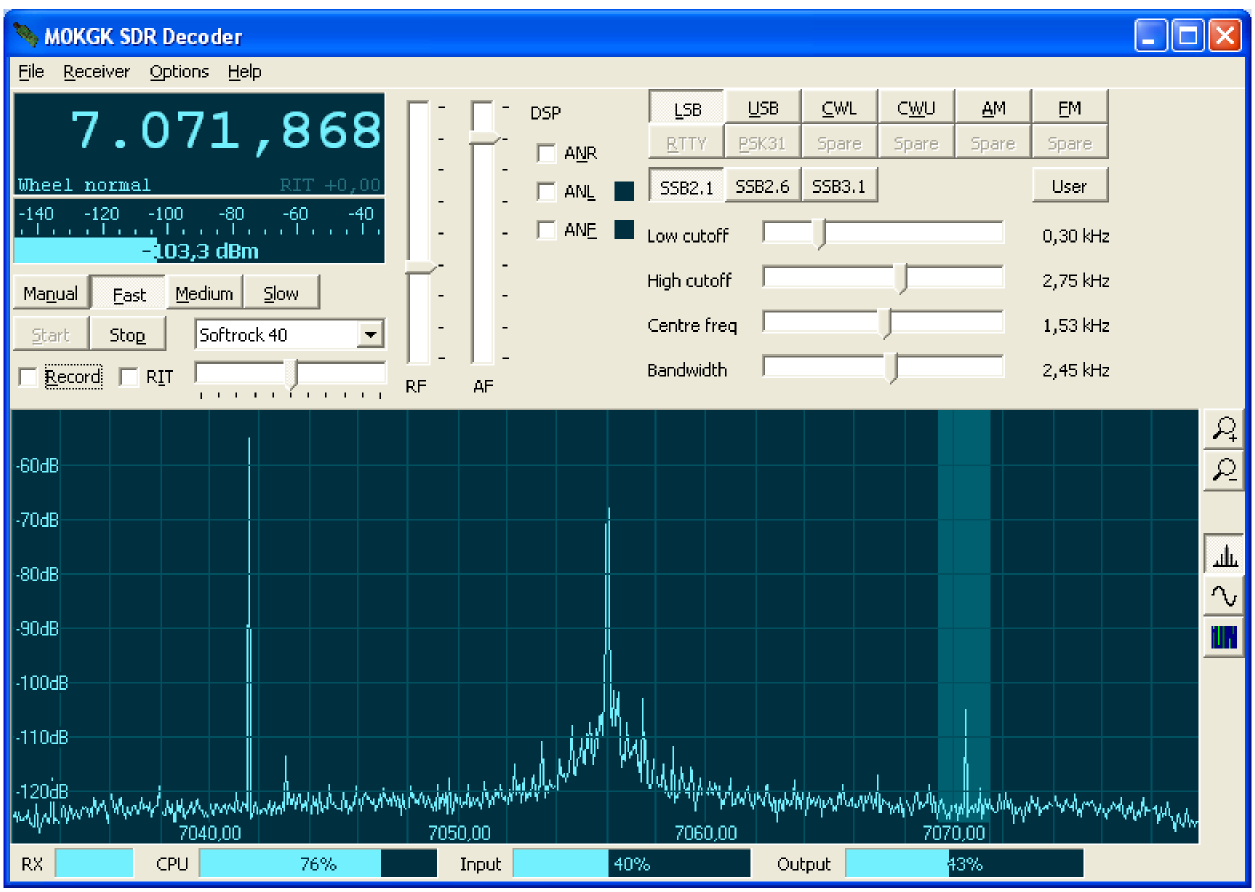




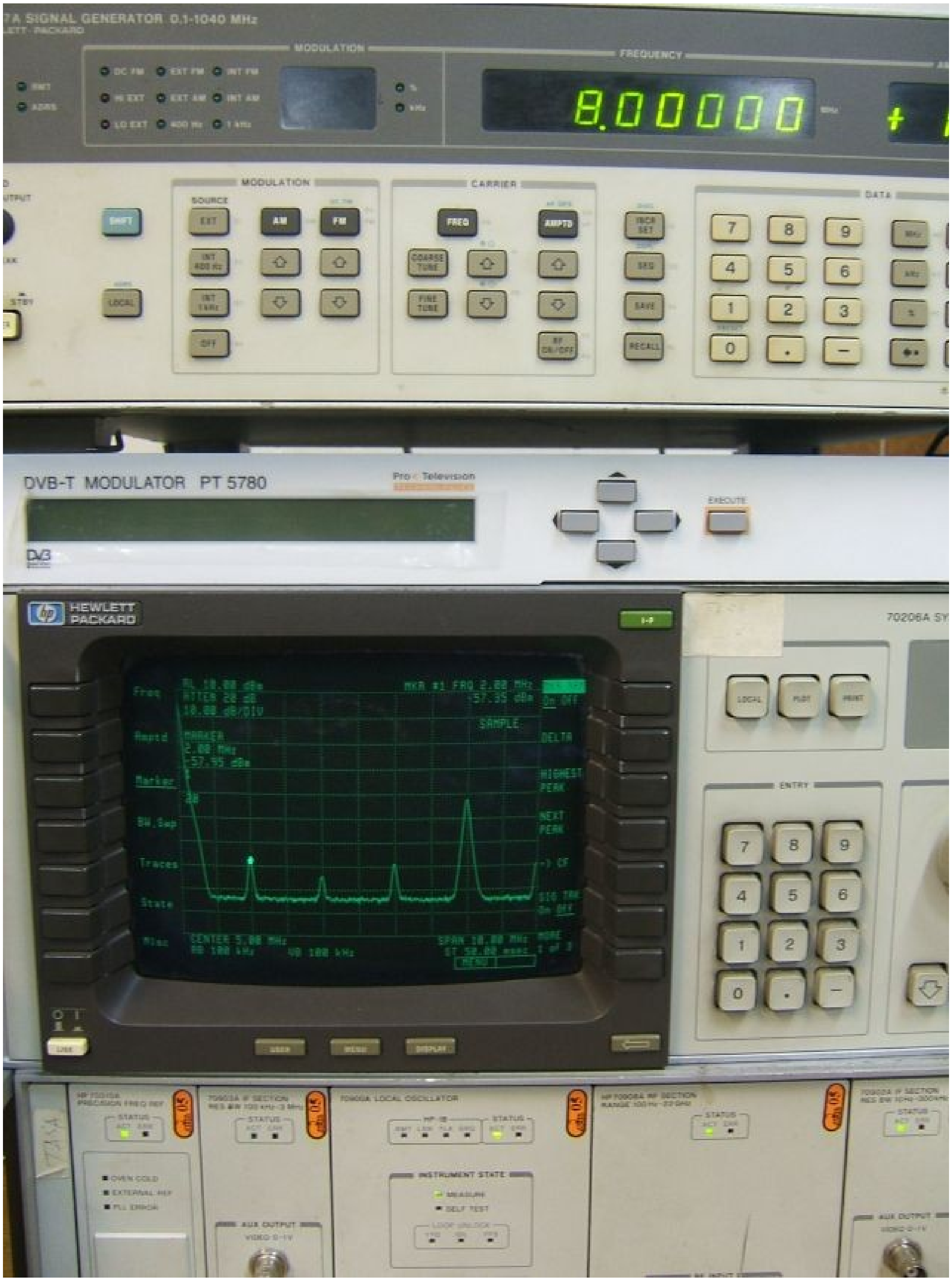
Norbert made image measurements in few programs also, see screens shots down :



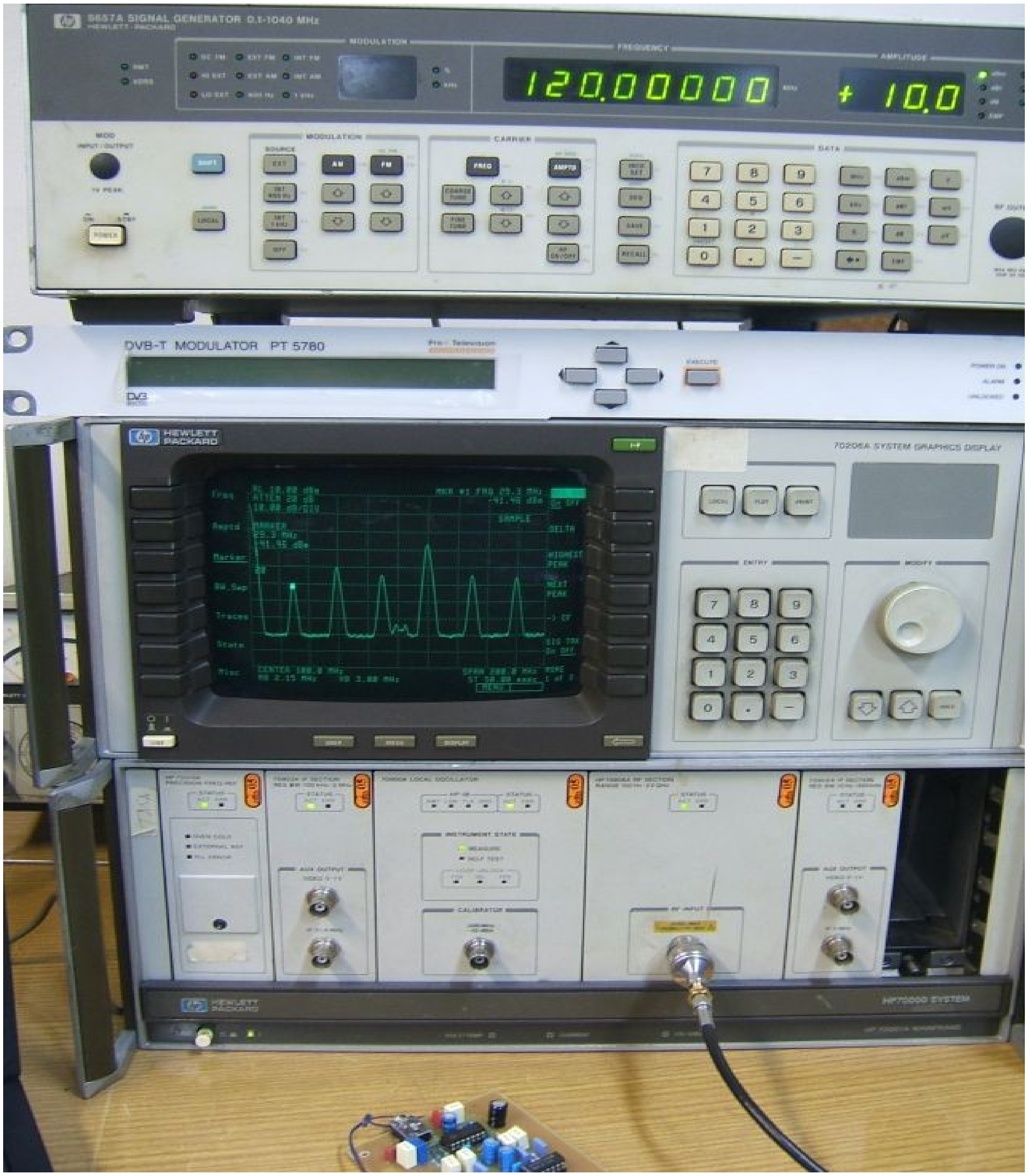

SDRadio
Version 0.99
? Help
_ Minimize
X Exit
Options
10015.84 kHz
by Alberto I2PHD
AGC Gain
Lo
Mid
Hi
Denoiser
Rx
St.By
Level
48 kHz
24 kHz
12 kHz
6 kHz
3 kHz
Freq. span
Fine Tune
+0 Hz
Phase delta
AM
ECSS
USB
LSB
FM


M0KGK SDR Decoder
File
Receiver
Options
Help
7.071,868
Wheel normal
RIT +0,00
-103,3 dBm
Manual
Fast
Medium
Slow
Start
Stop
Softrock 40
Record
RIT
RF
AF
DSP
ANR
ANL
ANF
LSB
USB
CWL
CWU
AM
FM
RTTY
PSK31
Spare
SSB2.1
SSB2.6
SSB3.1
User
Low cutoff
0,30 kHz
High cutoff
2,75 kHz
Centre freq
1,53 kHz
Bandwidth
2,45 kHz
RX
CPU
76%
Input
40%
Output
43%

The main discussion between us was about LO isolation and LO leakage at DR2A RX input. It is hard define LO power because it is not terminate (square LO power measured at 50 Ohms are between +15 dBm to +17 dBm). Because of that I bring you absolutely level measured on AS spectrum analyzer screen. Pictures are for the DT2A transmitter but pictures for DR2A are very similar few dB up or down. Here we can see 50/50 % duty ratio advantage over multiplexer 1/4 widely use in other SDR design. Top level at AS are +10 dBm. This kind of receiver because of that has small or neglected sensitivity to the harmonic receiving .



At first picture RX tuned at 2 MHz you can see that is LO leakage at level -58 dBm or assuming that is LO level +10 dBm LO rejection is 68 dB!!! Similar results are for 2 (lower than receiving frequency as results of perfect 50/50 % duty ratio miss of even harmonics), 3 harmonic and only LO fundamental (4 time the receiving frequency) is passing by out with higher level -33dBm absolutely. Situation at higher frequencies isn't good as it is at 2 MHz but it is still very good if we have at mind that is single side PCB RX realization



.

At receiving frequency 30 MHz LO leakage is at level -42 dBm absolutely level. It is LO suppression of 52 dB!!! Other harmonics have now higher levels because of finite slew rate and turn ON/OFF times for switches inside IC 74HC4066. LO fundamental (4 time the receiving frequency) is now rejected only 28 dB or absolutely level is -18 dBm.

VY 73/72 GL in SDR homebrew Tasa YU1LM/QRP

SDR PCB and Schematics Corrections for YU1LM/QRP Projects

Here is list of all my errors in my 3 articles which I knew in this moment. I am so sorry for them and I am apologizing to all for inconveniences. I also want to thank you to all who send me messages about my designs and especially for mistakes which you have found.

1. First part:

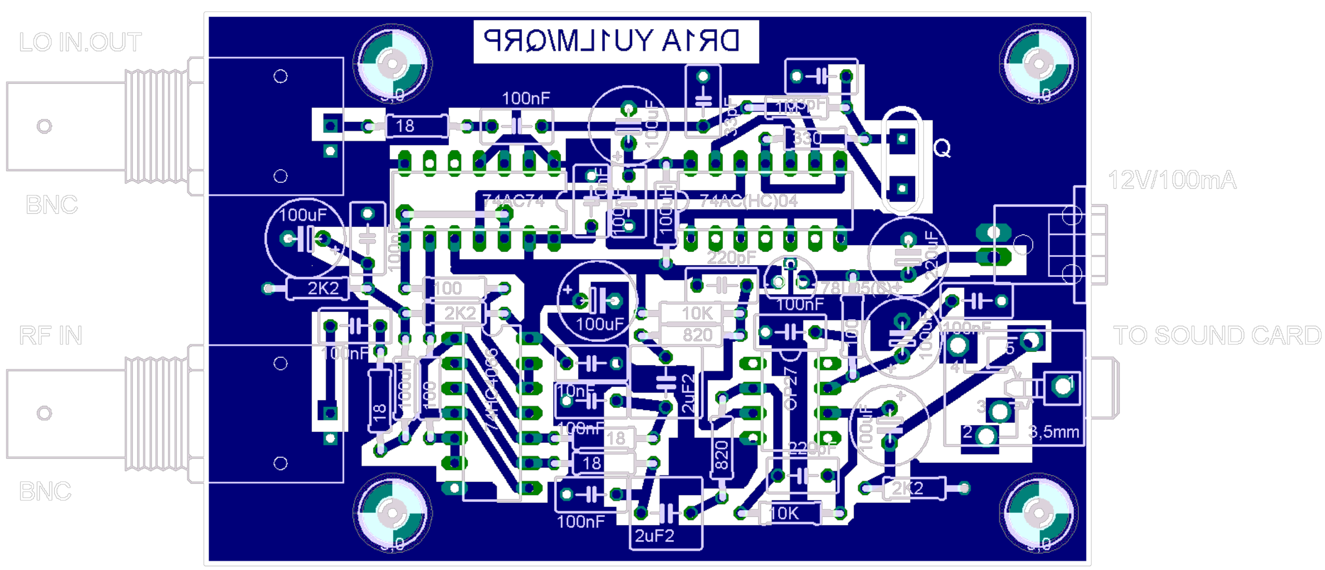
-in DR1 78L05 is not oriented correct (turn on it for 180 DEG and shape GND pin)
- In schematic VCC for 74AC02 I missed one choke 100uH, 100uF and 100nF
-better values for R7, R8 are 1K instead 2K2, better ½ VCC divider
-better values for R11, R12in DR2 are 1K instead 2K2, better ½ VCC divider

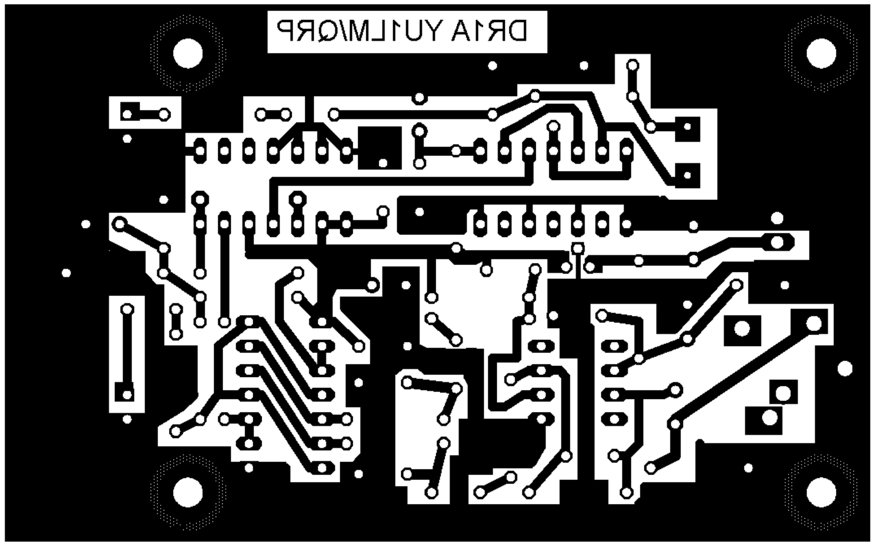
2. Second part:

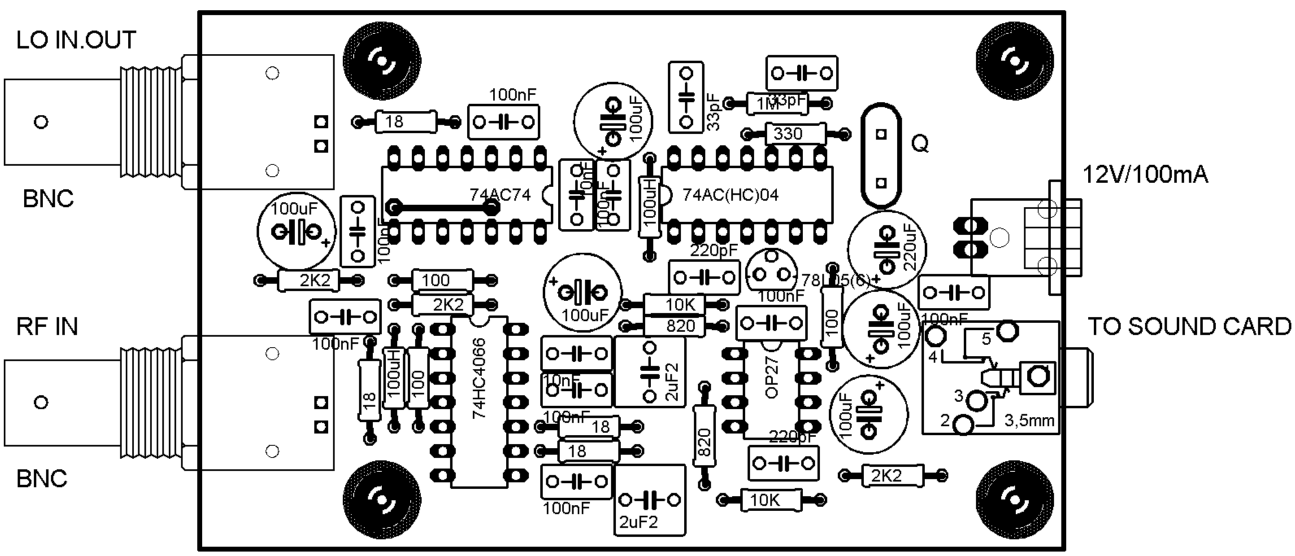
-for IC1 74HC4066 I missed choke 100uH, 100uF and 100nF in +VCC branch

3. Third part:

I made next mistakes:
DR1A correct schematic PCB is down (I turned for 180 DEG 78L05)





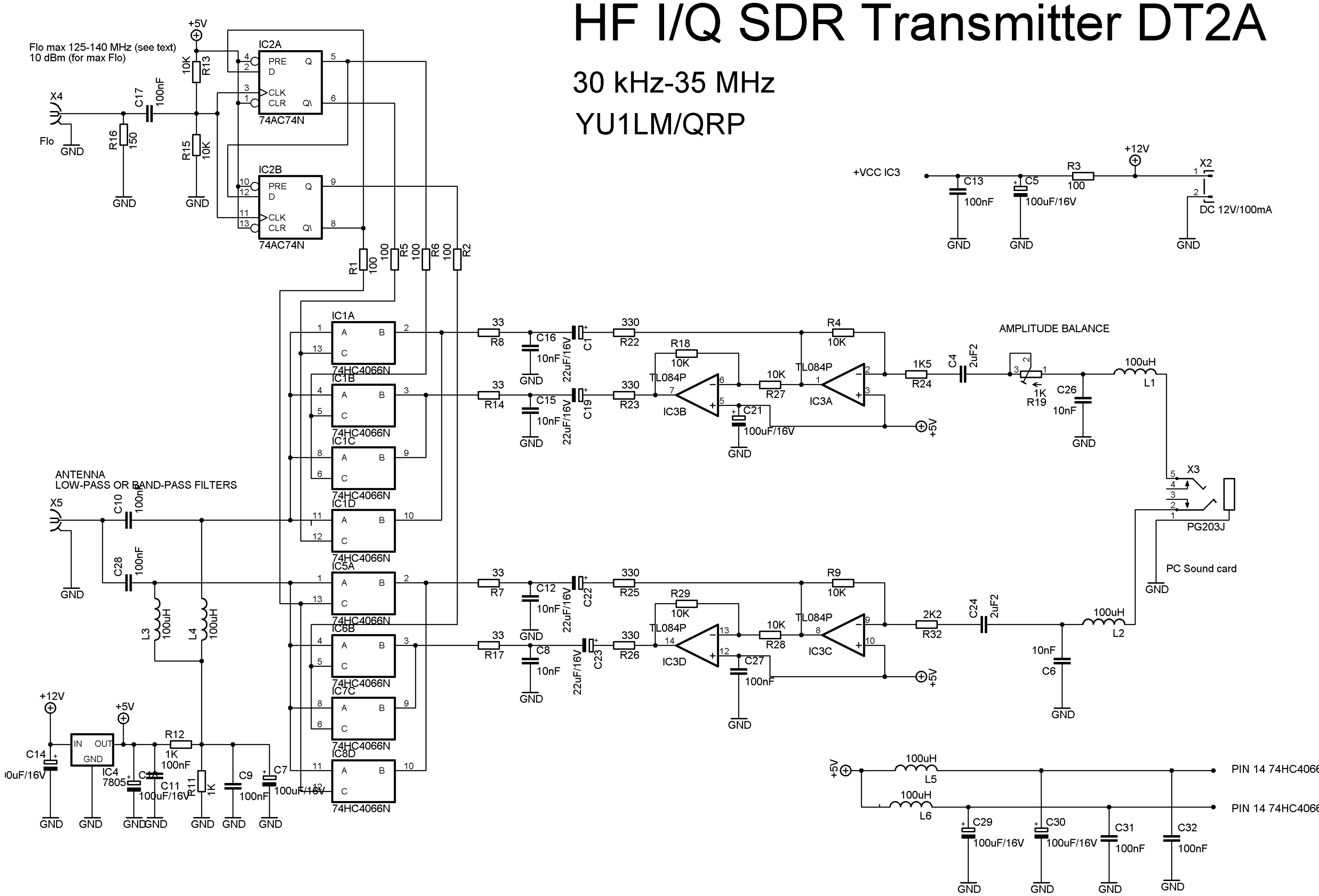


For DT2A SDR Transmitter I published wrong version of schematics. Correct schematic is shown down and PCB published previously was for the DT2A transmitter.

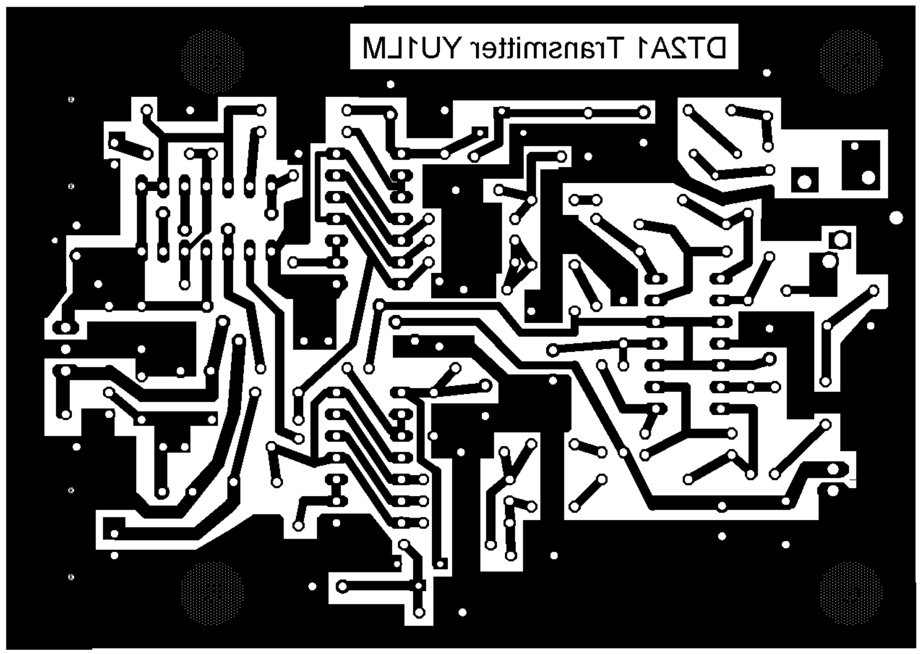
HF I/Q SDR Transmitter DT2A

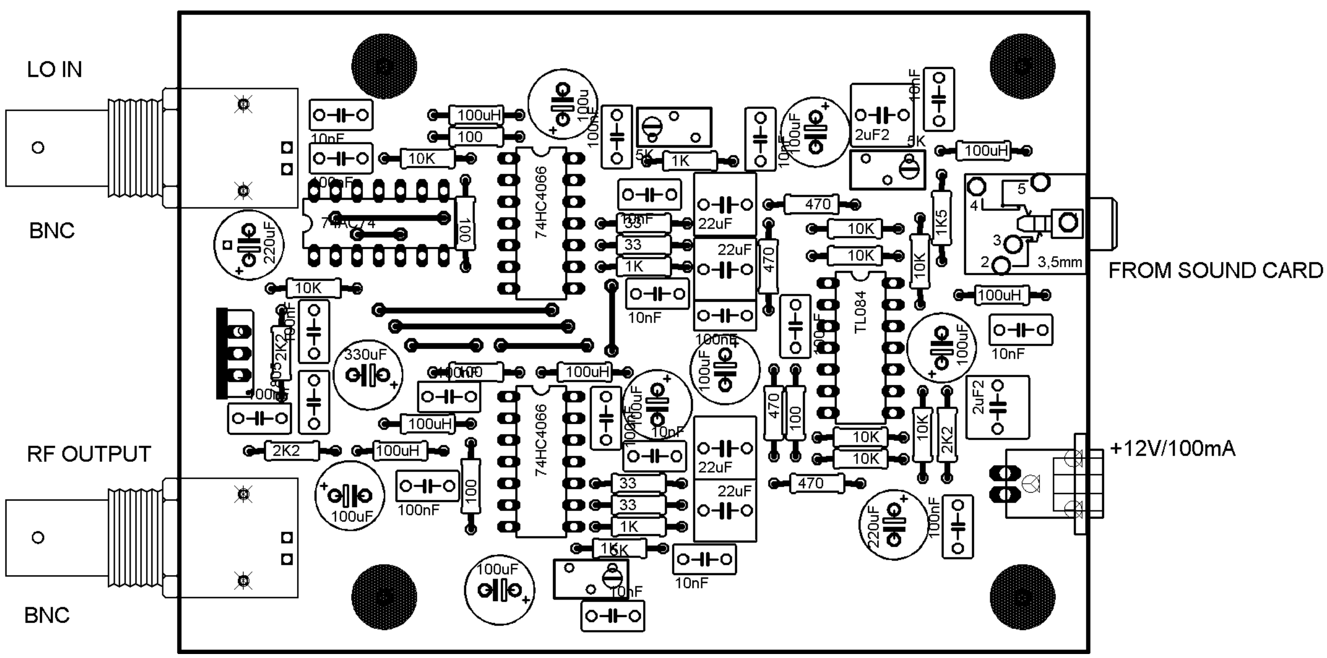
30 kHz-35 MHz

YU1LM/QRP



PCB and parts placement at site article is for this schematic up. DT2A schematic at site is DT2A1 version of DT2A and PCB for it is down with parts placement. I also propose new PCB with lower LO leakage and better LO suppression than original DT2A.

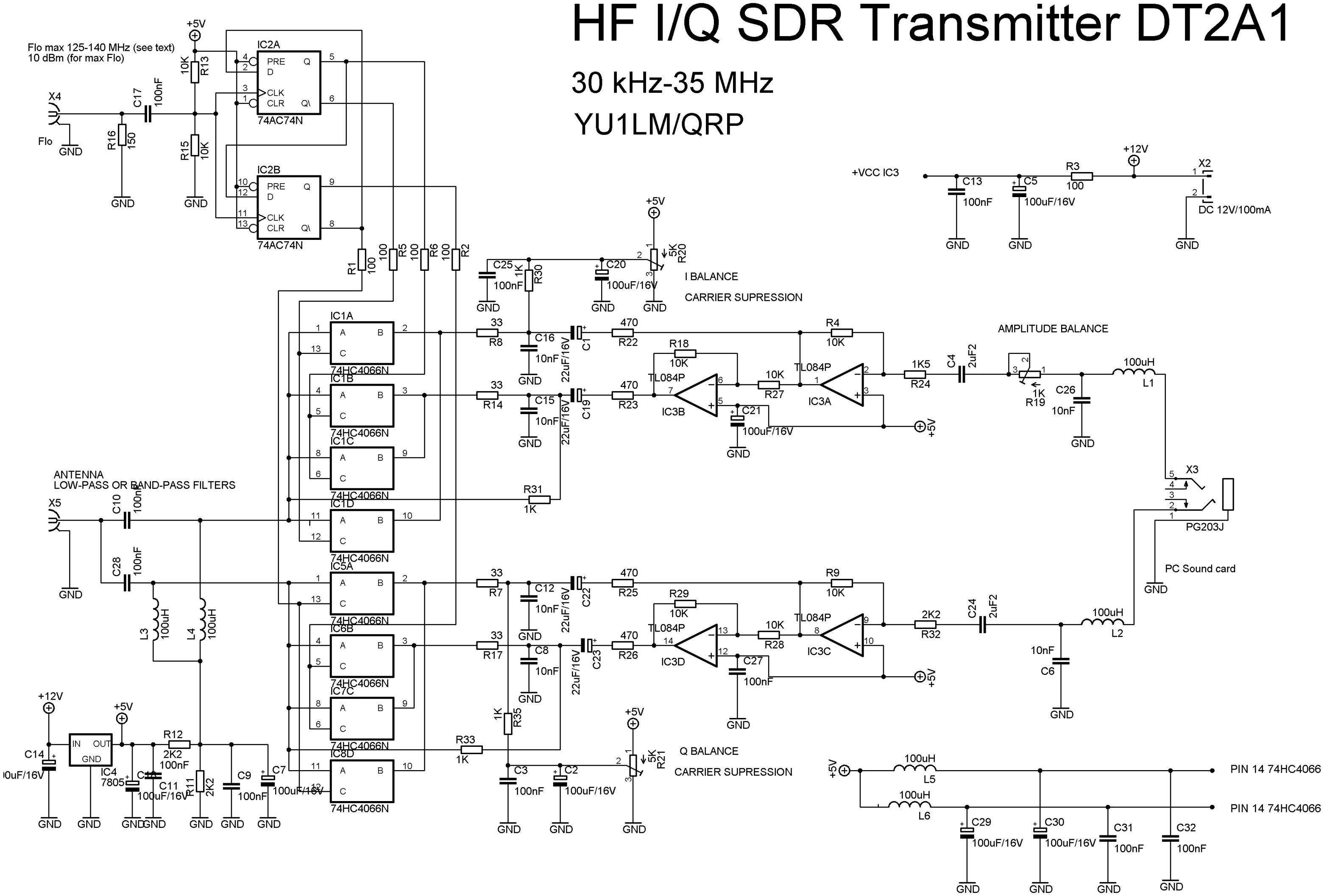




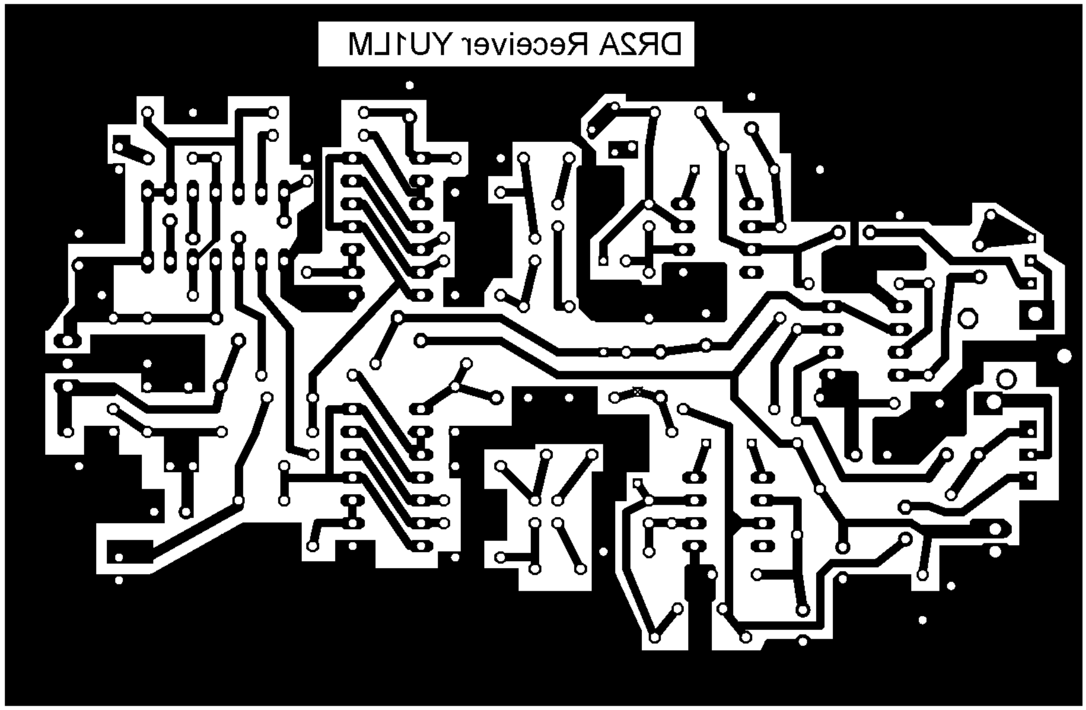
HF I/Q SDR Transmitter DT2A1

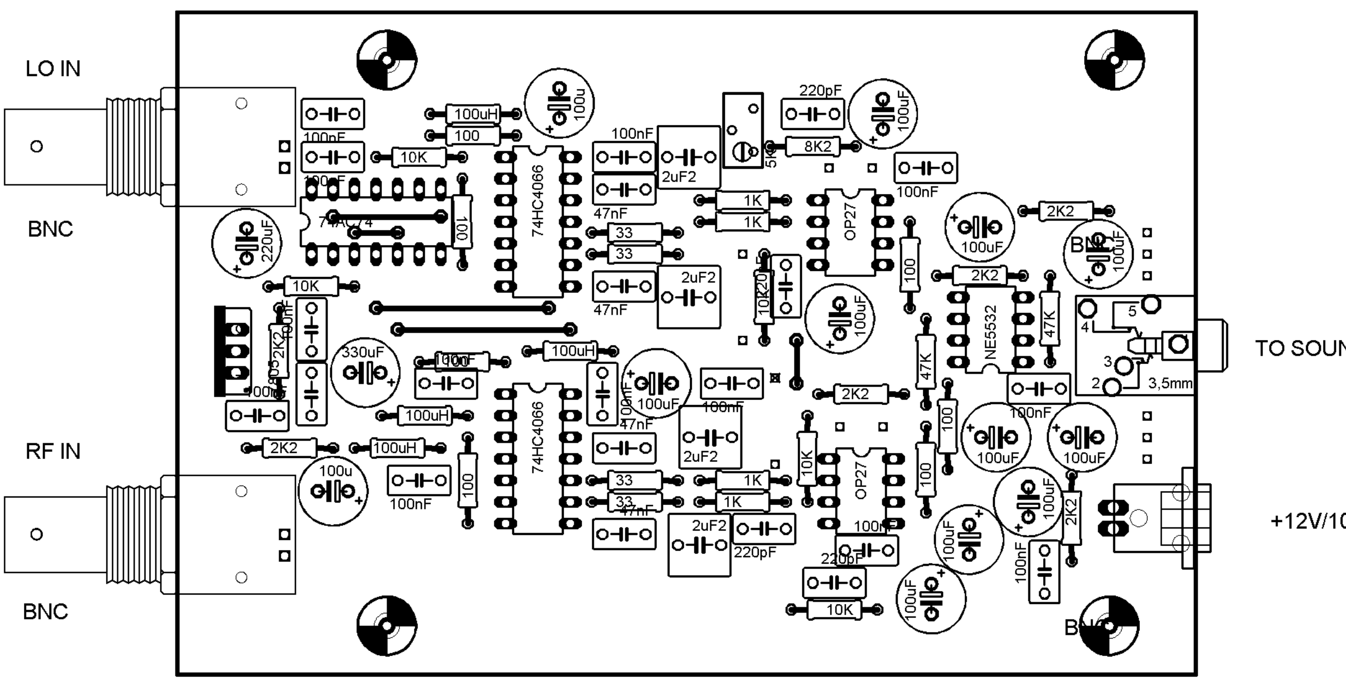
30 kHz-35 MHz

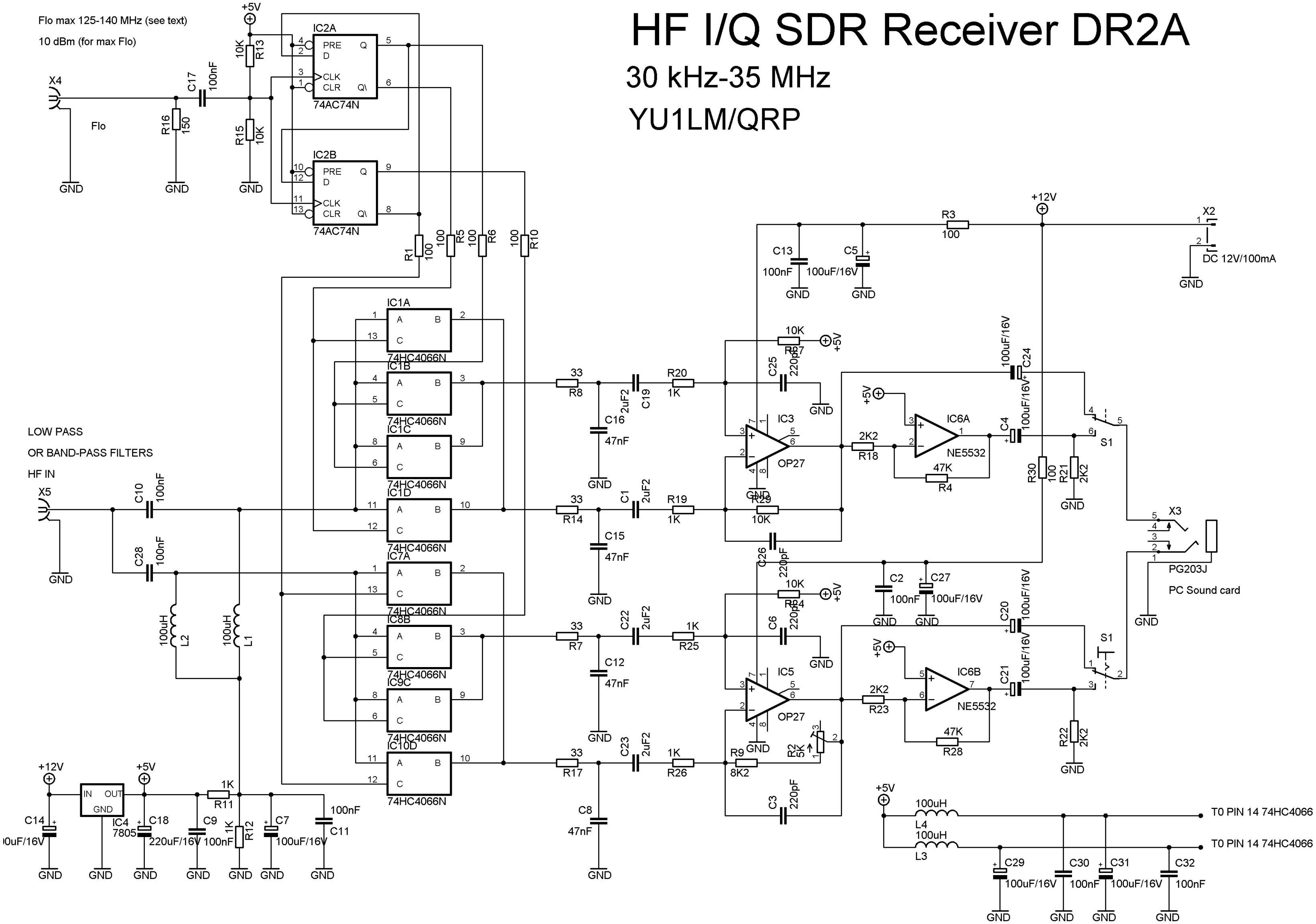
YU1LM/QRP



These corrections are for the third part. DR2A have minor changes and correct schematics PCB and placement for DR2A RX are down.

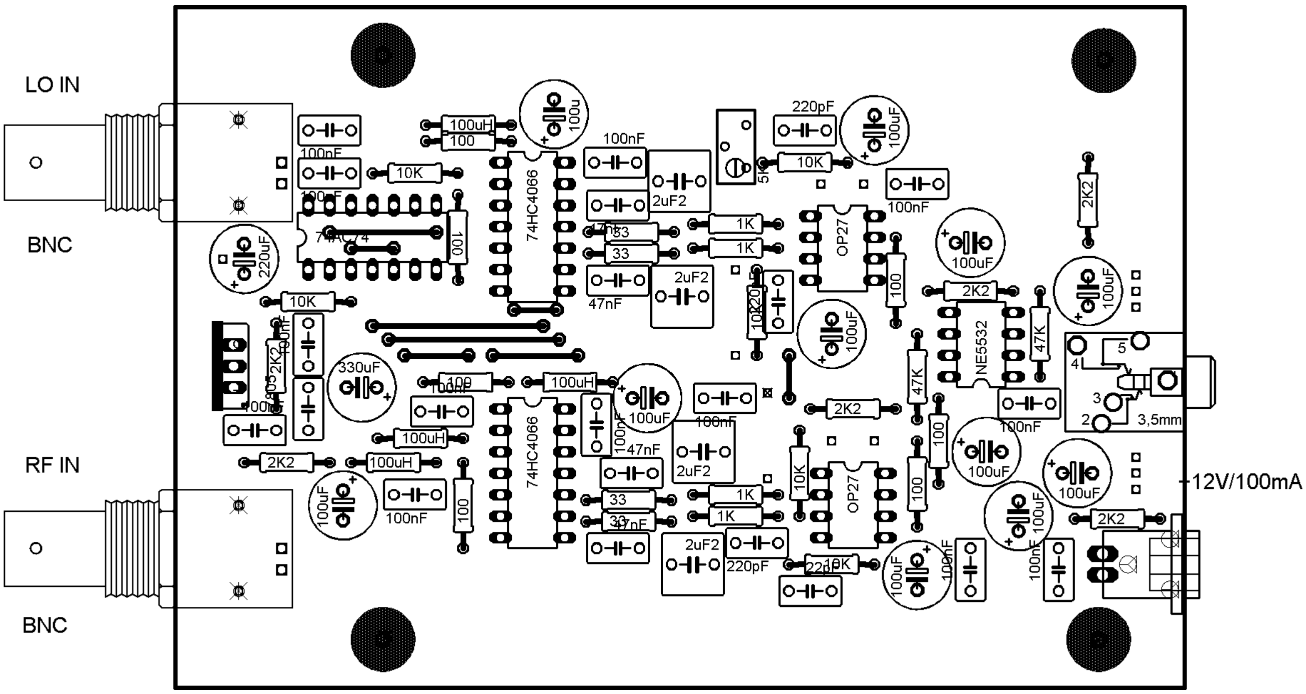


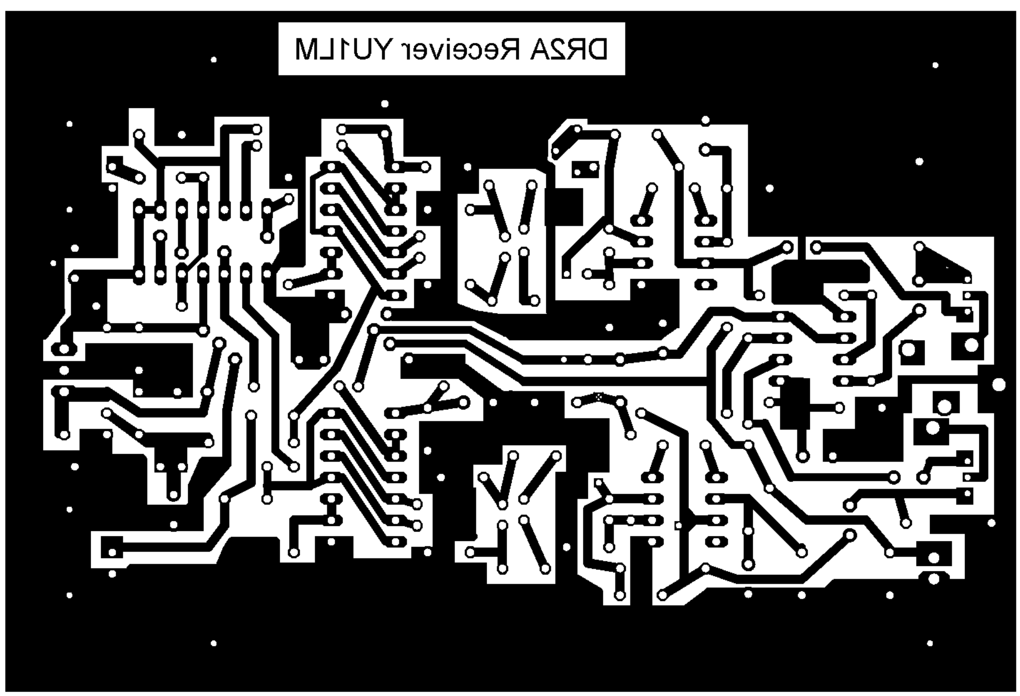




HF I/Q SDR Receiver DR2A
30 kHz-35 MHz
YU1LM/QRP
Flo max 125-140 MHz (see text)
10 dBm (for max Flo)
Flo
LOW PASS
OR BAND-PASS FILTERS
HF IN
DC 12V/100mA
PG203J
PC Sound card
T0 PIN 14 74HC4066
T0 PIN 14 74HC4066

In meanwhile I made improved PCB for DR2A RX to lower LO leakage see down.



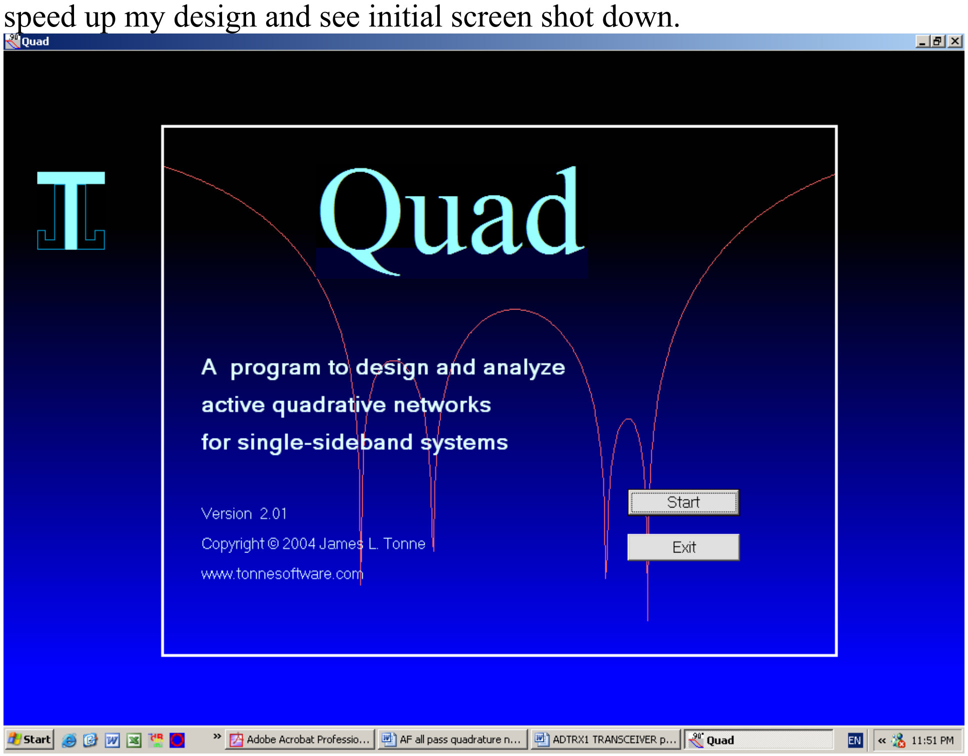


VY 73/72 and GL in SDR homebrew Tasa YU1LM/QRP

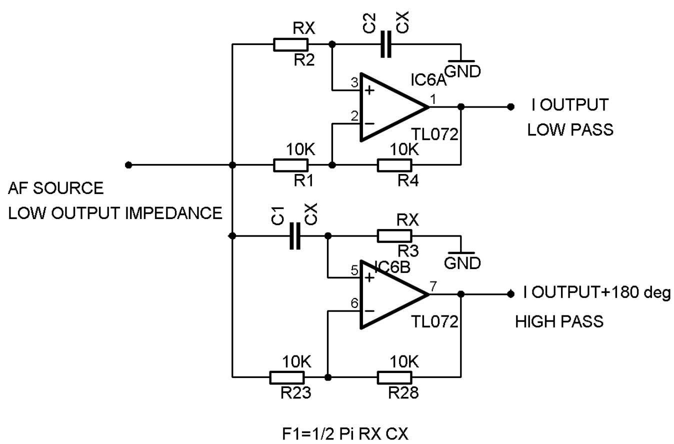
An AF All pass Quadrature Networks Practical Approach old Technique Revised

Dipl. Ing . Tasić Siniša –Tasa YU1LM/QRP

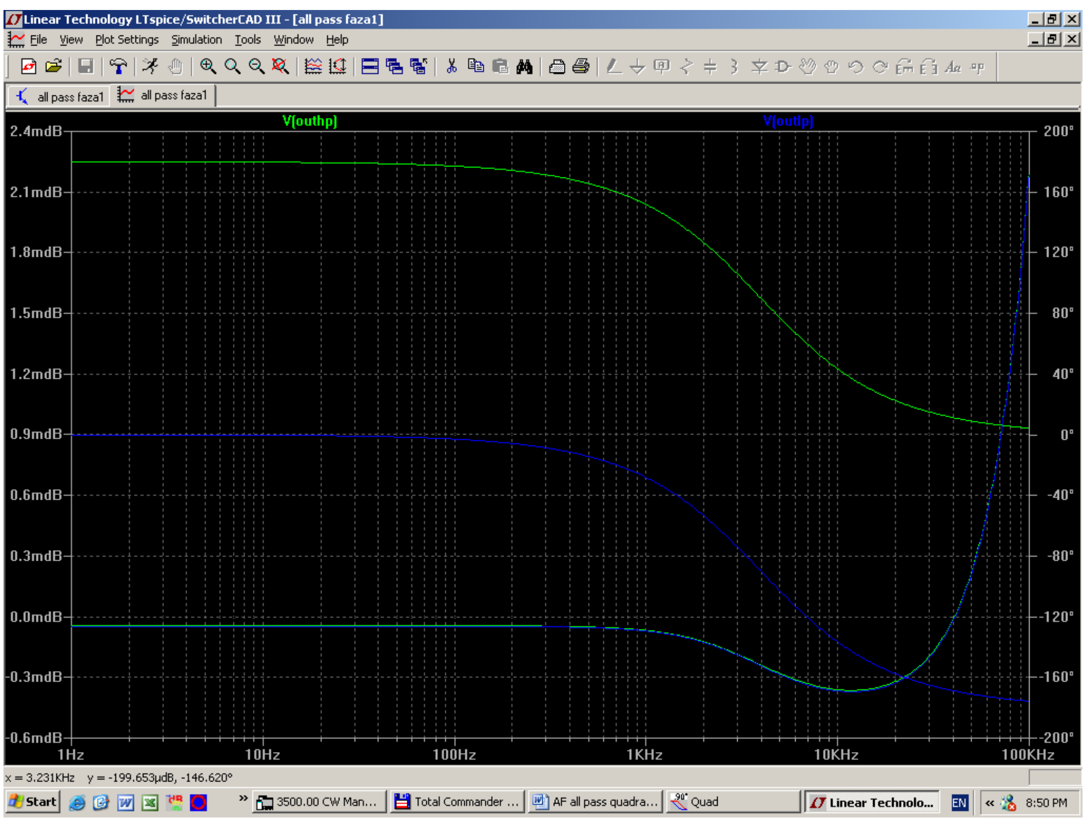
An all pass audio quadrature networks as subject was in focus of mine interest few years ago when I was dealing with image rejection direct conversion receivers design. Some results and how it can be realized them I publish in article "***Renaissance of HF DC receivers***" on this site. Article contains 30 pages collected materials about DC receivers with schematics, useful formulas for calculations, PCBs and complete receivers made or design by author. I apologize that this materials are written on Serbian language but schematics, formulas and PCBs are useful for everyone who is in the touch with the direct conversion receivers. I would like to design an SDR transceiver contest grade quality. I was waiting long time to obtain some freeware SB (sound card) software for SDR transceiver but still stay only hope. We still haven't free transmission programs for SSB/CW….In meanwhile I made HF SDR transceiver called ADTRX1 (analog + digital).Upper limit for ADTRX1 is 35 MHz and leak of adequate transmission software I solved with hardware realization. First I started with the CW operation. Solution for CW is a very simple and easy and contains only one audio frequency, audio sub carrier, with quadrature outputs I/Q (90 DEG). Audio sub carrier frequency region between 4-10 kHz was obtaining from the board B2 dividing few MHz oscillator inside IC 4060 with binary divider and filtered with AF LP(low pass) network I connected very clear sinusoidal signal to the two stage all pass phase shift network realized with OP AMP . Adjusting I/Q outputs was very easy and my SDR transceiver was now ready to go on the air. Opposite side band rejection was satisfied and with careful adjustment reached 50 dB and more. A broadband result was better than 40 dB. This result was good for the simple network with one IC TL084 with 4 OP AMP inside. After that I decided to try digital modes and useful audio range have to be much wider than one kHz or more compared to single frequency for the CW. Experimenting with networks I find on INTERNET very interesting free software www.tonnesoftware.com which help me to improve and speed up my design and see initial screen shot down.



The design/simulation was now really very easy and determinations components variation spread up and their influence to the final result was new light for me. It was possible for me to obtain similar results in some CAD but adding this Monte Carlo part took to much time and I don't like it if it is necessary. Program is for modulators and demodulator circuits realization as HP (high pass) network but I am using complementary (dual) circuit see schematic and simulation for both networks are down. From results it is evident that it isn't important HP or LP realization only component values.

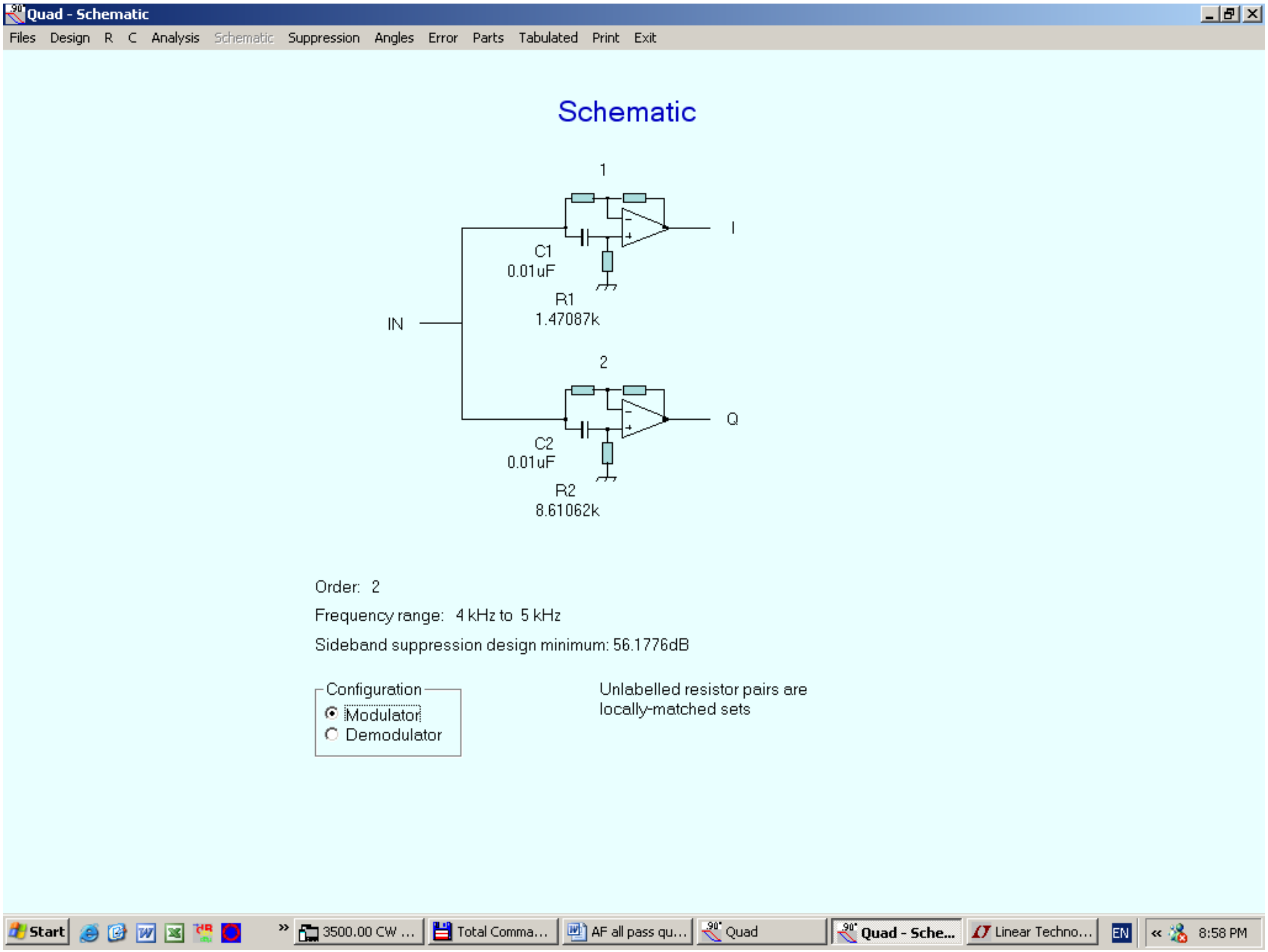


SCHEMATIC AS ILUSTRATION 2 POSSIBILITY FOR AF SHIFT NETWORKS LOW PASS AND HIGH PASS VERSIONS

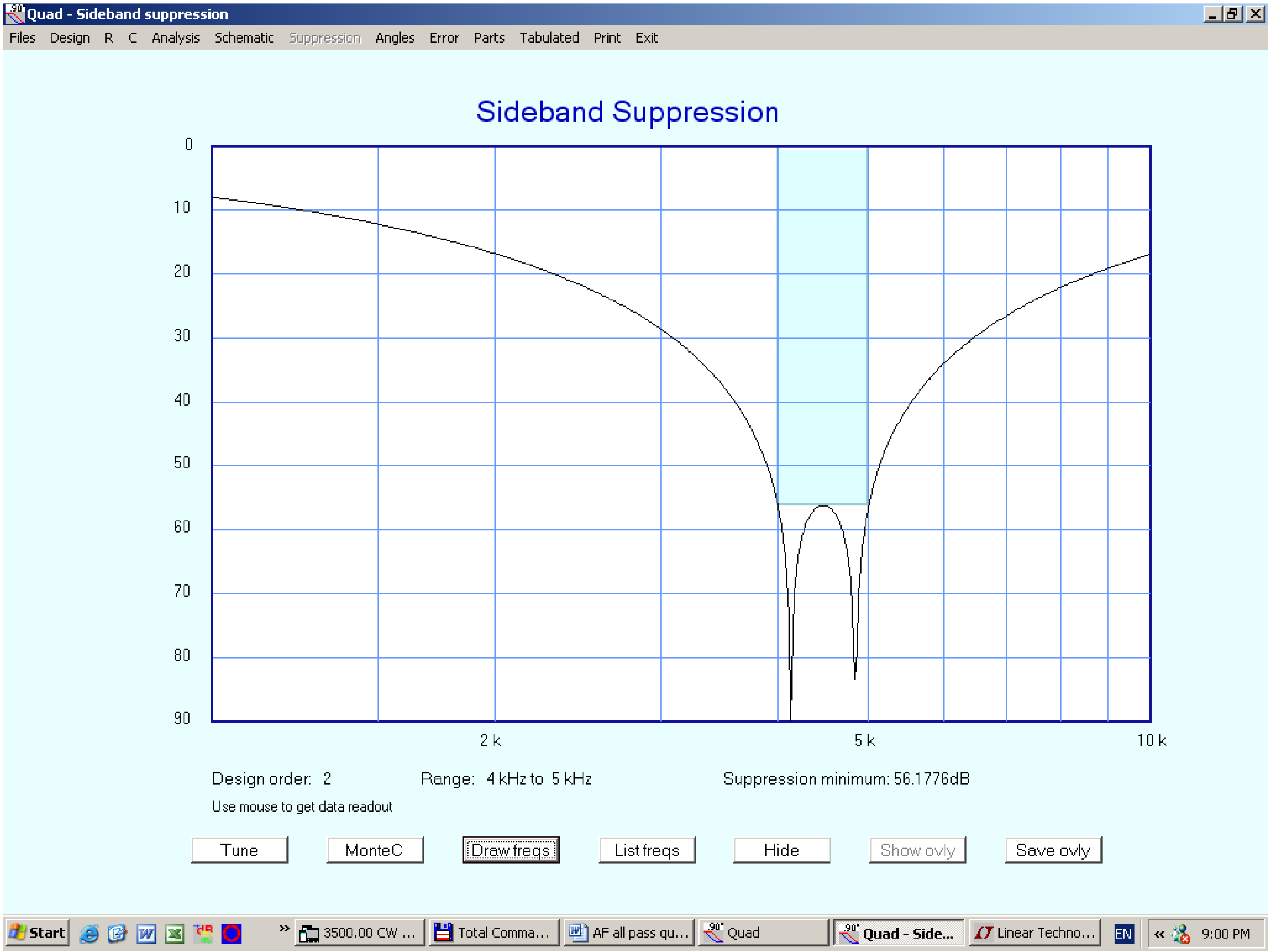


All design are with low pass networks original schematics from QUAD CAD is high pass components values are the same except that R and C have to change places in networks which is connected to the + input OP AMP. C in all networks is 10 nF 1% tolerances.

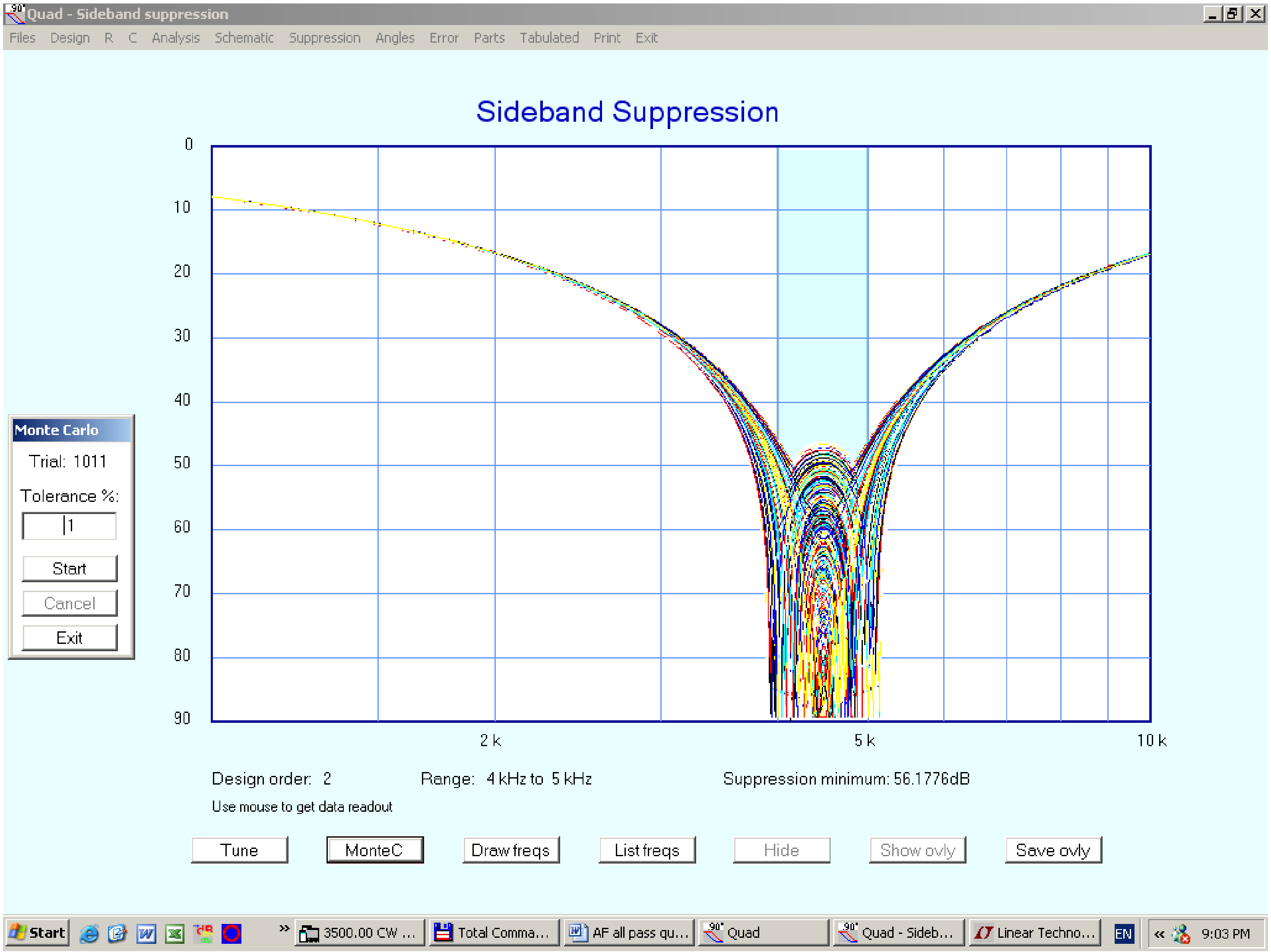
1. CW sub carrier 4-5 KHz I/Q phase shift networks is second order with one TL 072 FET OP AMP.



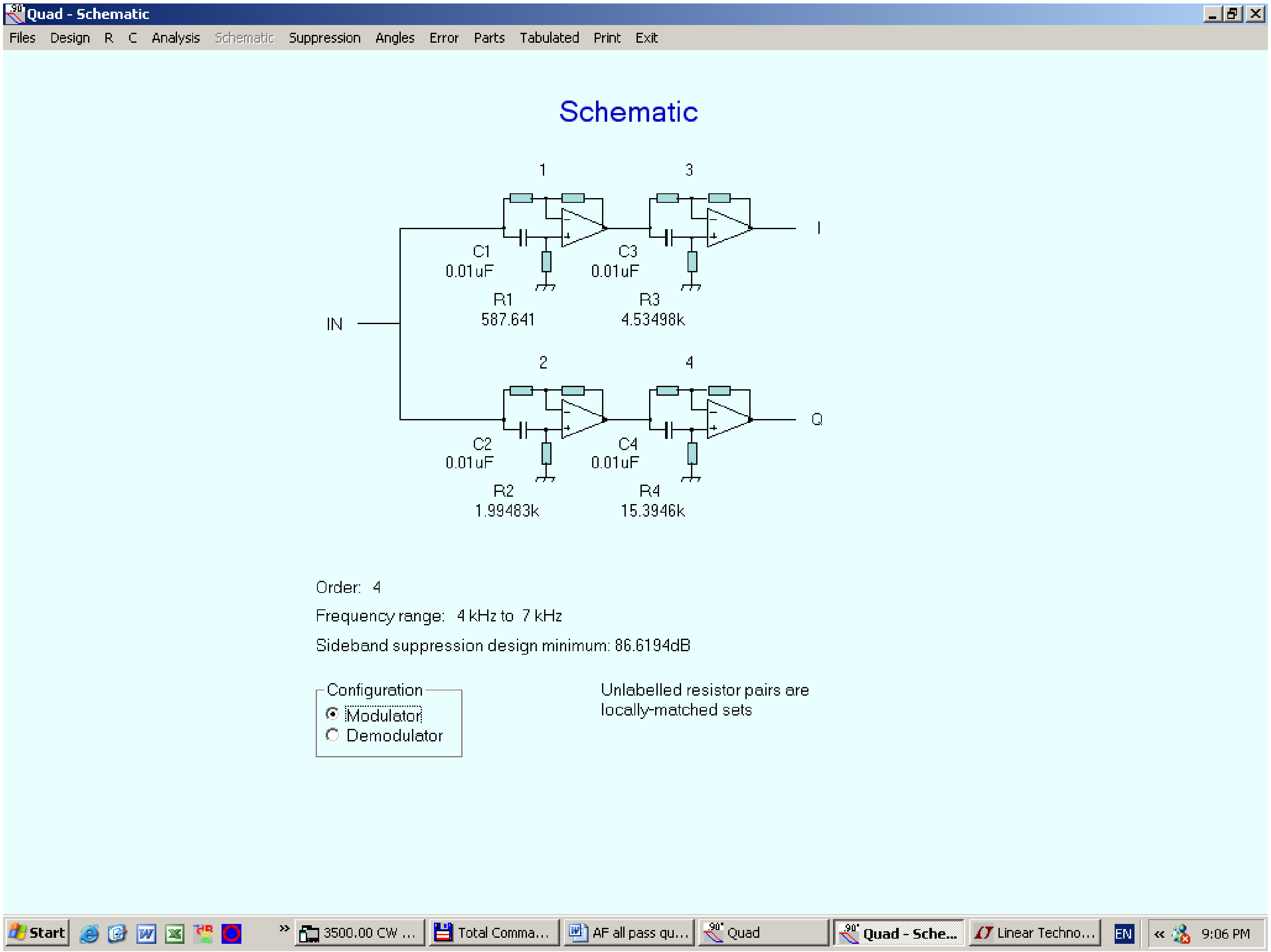
Ideal theoretical situation with opposite side suppression.



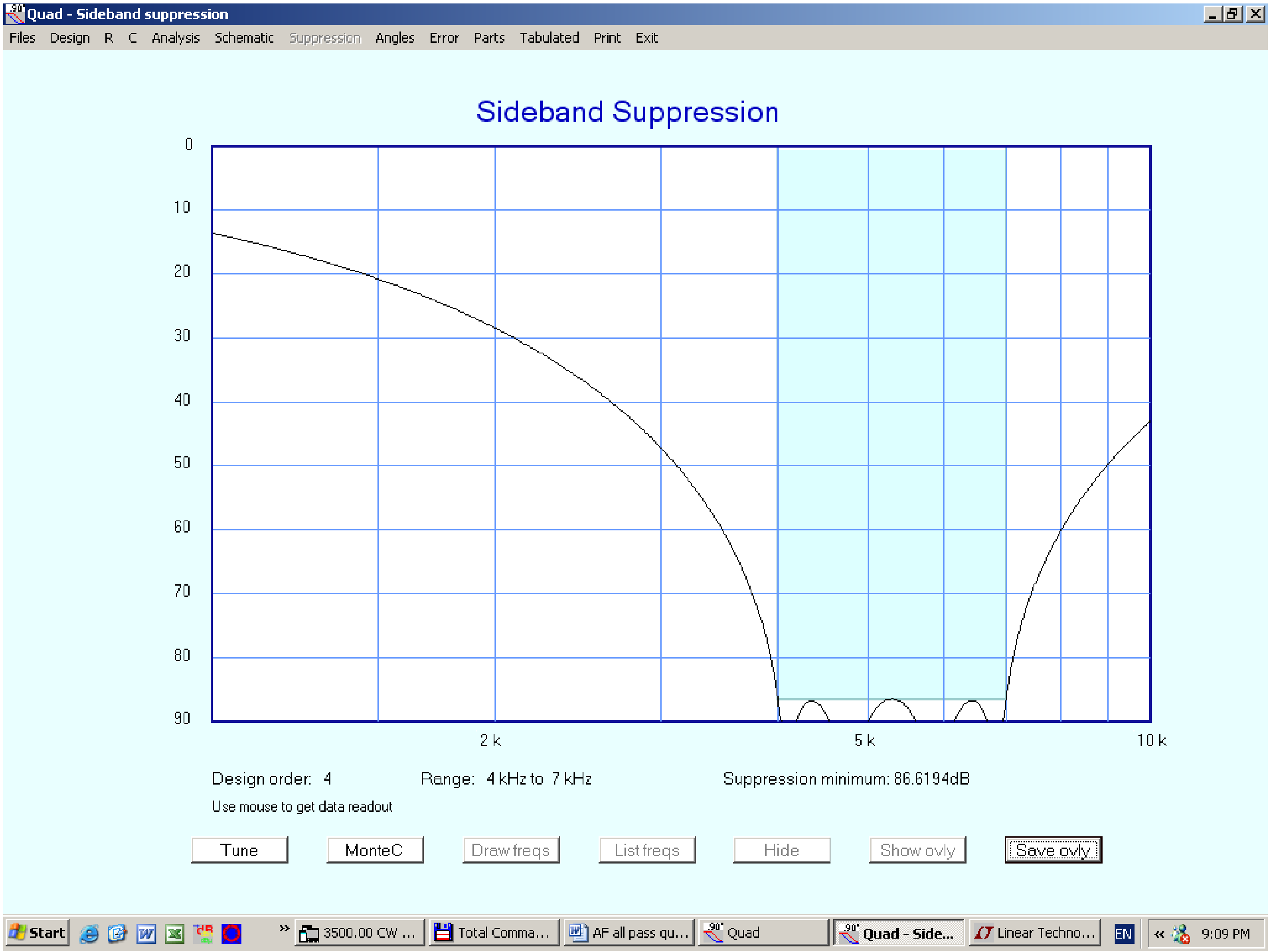
Influence of component tolerances to the final results and results which we can really expect with practical realization.



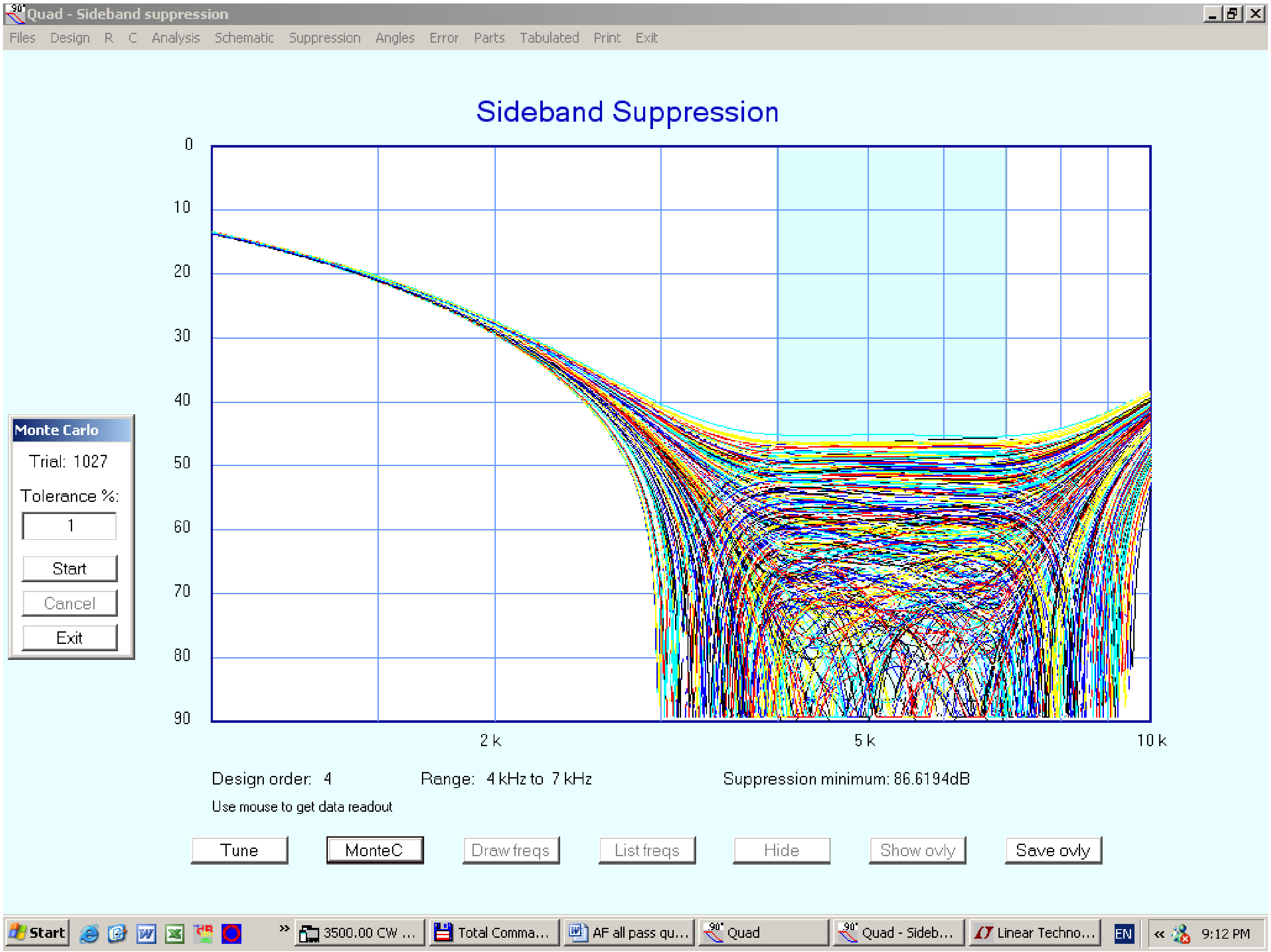
The same situation but with 4 order networks one TL084

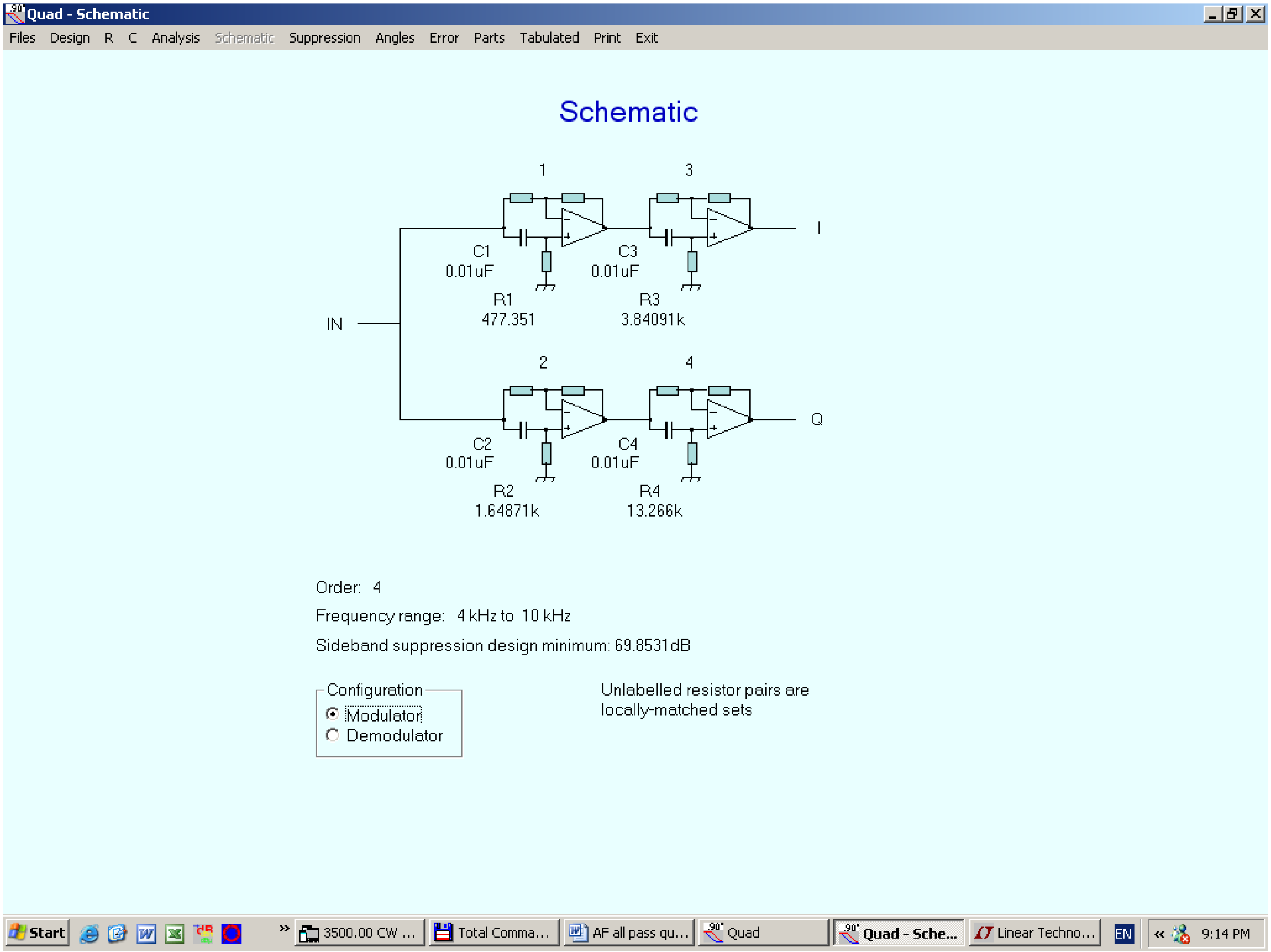


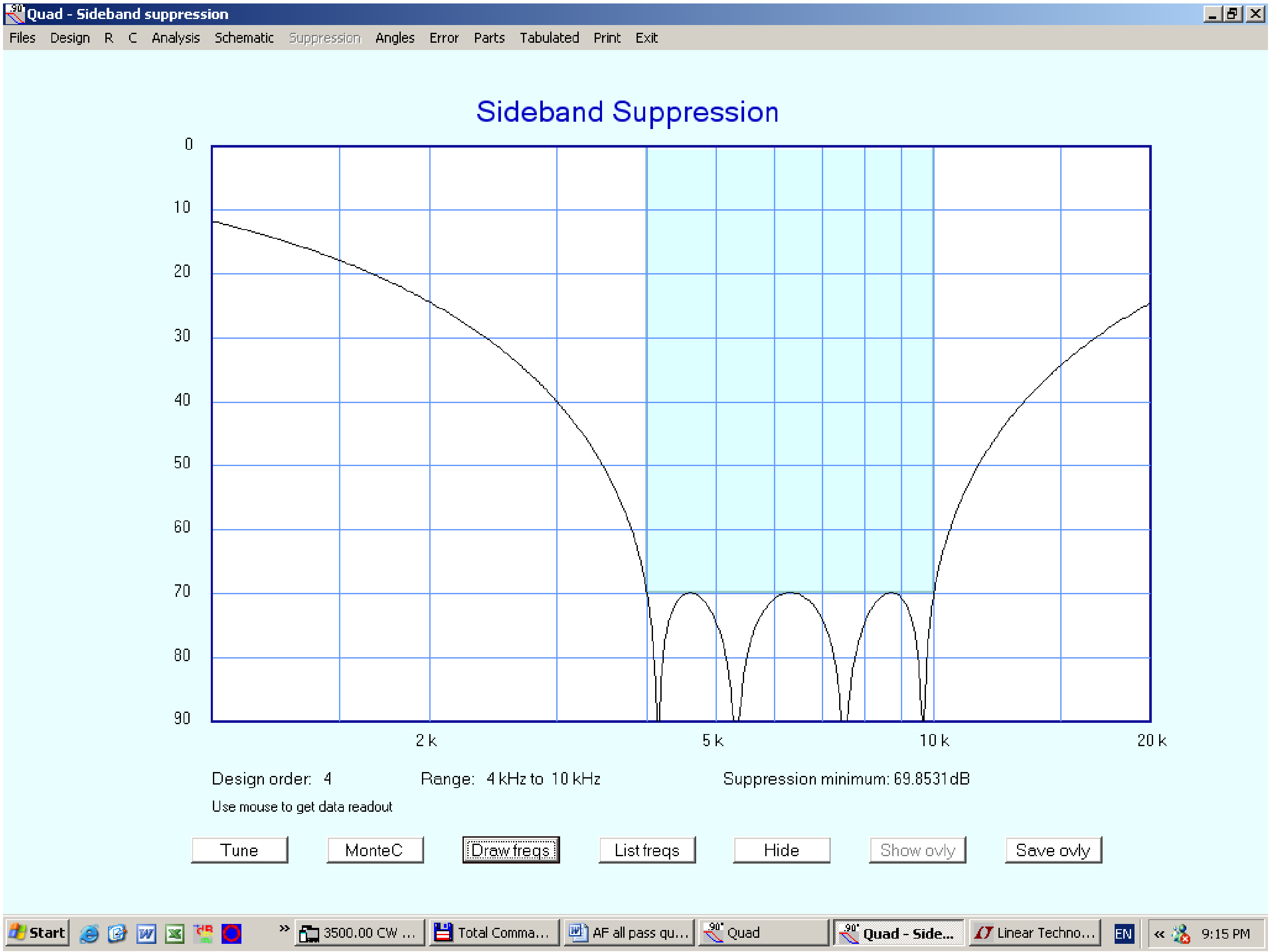
Ideal situation with sideband suppression

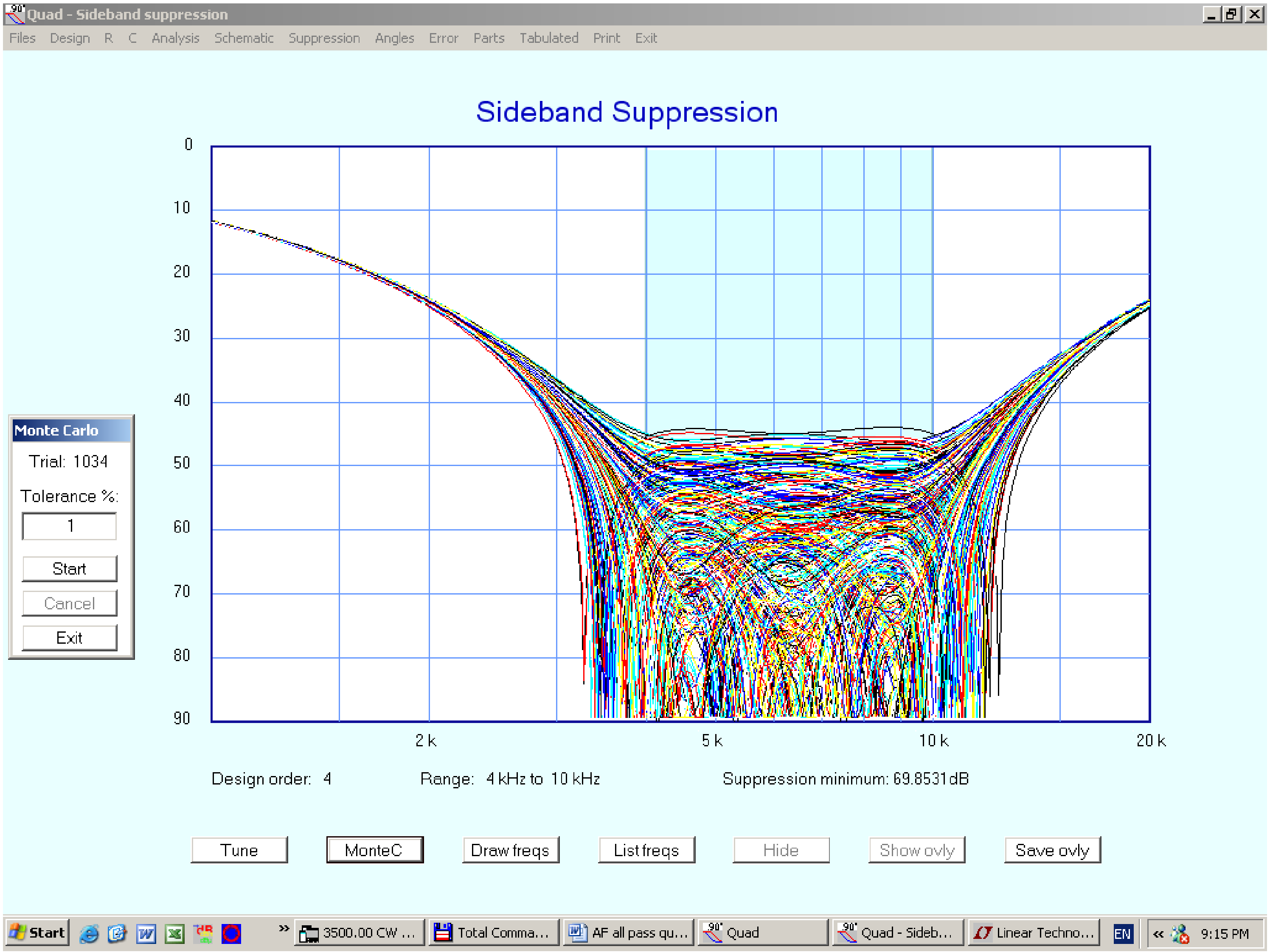


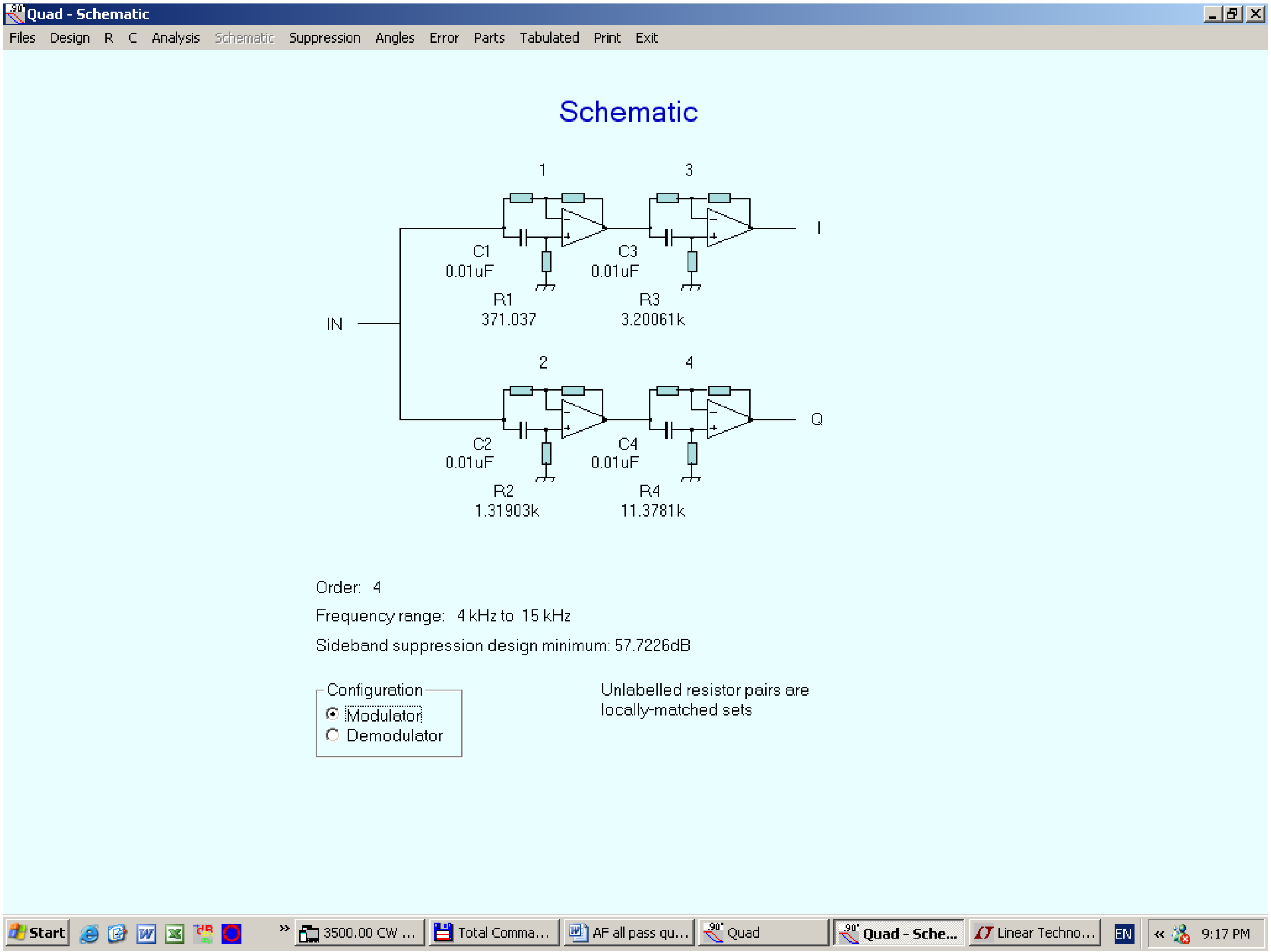
Component tolerances influence to the final results and results which we can really expect in practice

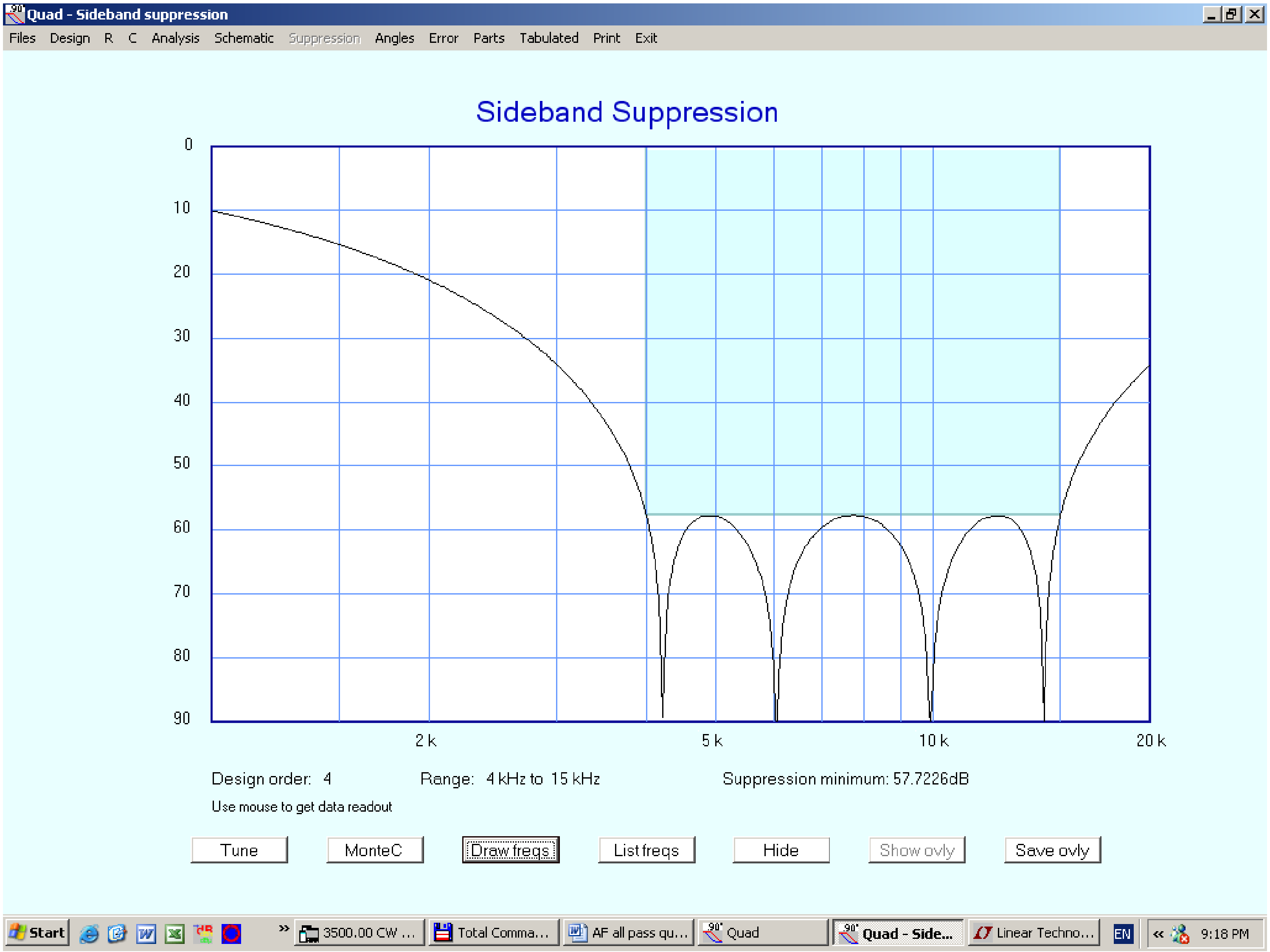

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
Monte Carlo
Trial: 1027
Tolerance %:
1
Start
Cancel
Exit
0
10
20
30
40
50
60
70
80
90
2 k
5 k
10 k
Design order: 4
Range: 4 kHz to 7 kHz
Suppression minimum: 86.6194dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Sideb...
Linear Techno...
EN
9:12 PM

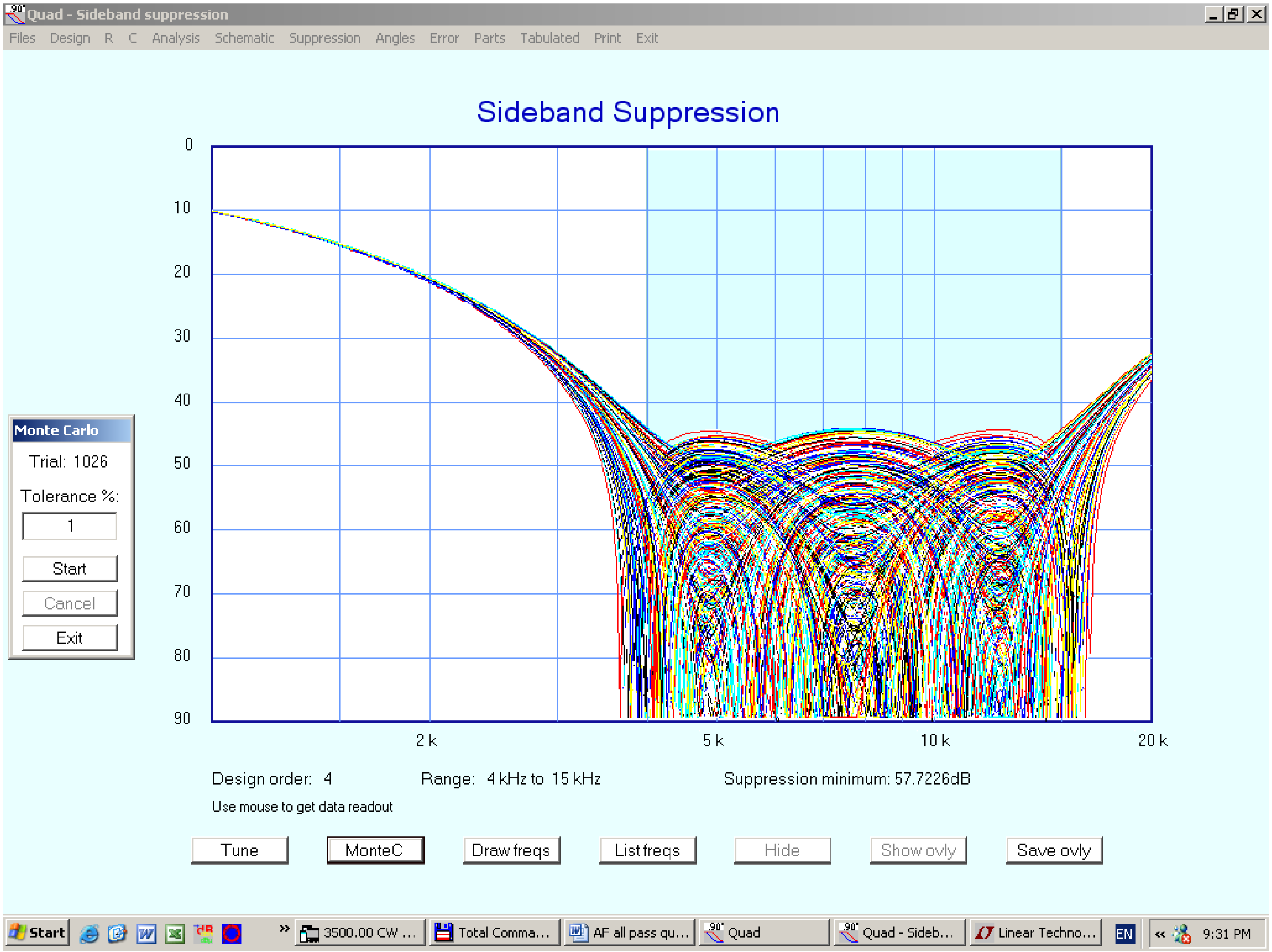

Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1
3
I
C1
0.01uF
C3
0.01uF
R1
477.351
R3
3.84091k
IN
2
4
Q
C2
0.01uF
C4
0.01uF
R2
1.64871k
R4
13.266k
Order: 4
Frequency range: 4 kHz to 10 kHz
Sideband suppression design minimum: 69.8531dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Sche...
Linear Techno...
EN
9:14 PM


Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
2 k
5 k
10 k
20 k
Design order: 4
Range: 4 kHz to 10 kHz
Suppression minimum: 69.8531 dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Side...
Linear Techno...
EN
9:15 PM

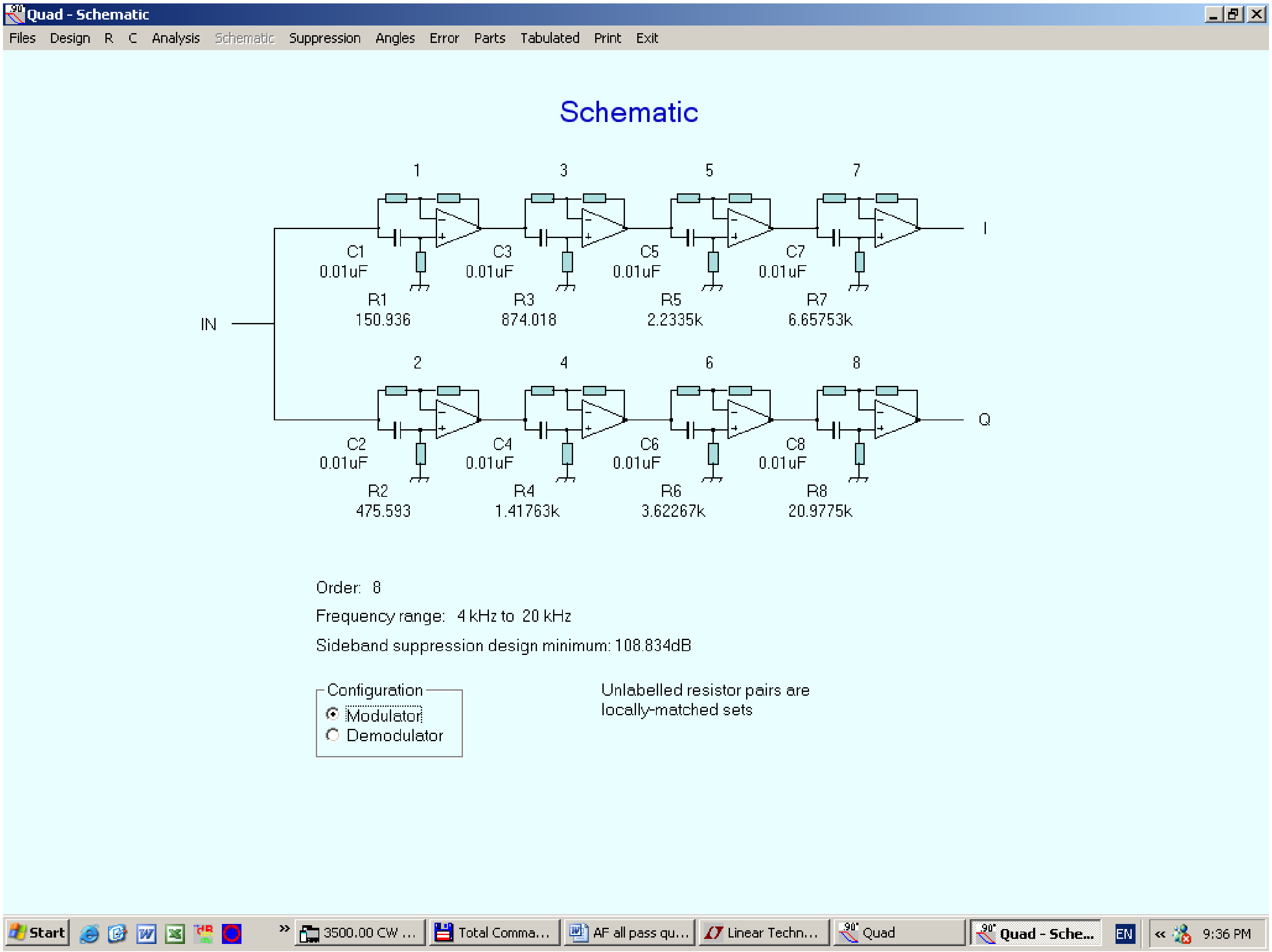

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
2 k
5 k
10 k
20 k
Monte Carlo
Trial: 1034
Tolerance %:
1
Start
Cancel
Exit
Design order: 4
Range: 4 kHz to 10 kHz
Suppression minimum: 69.8531dB
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Sideb...
Linear Techno...
EN
9:15 PM

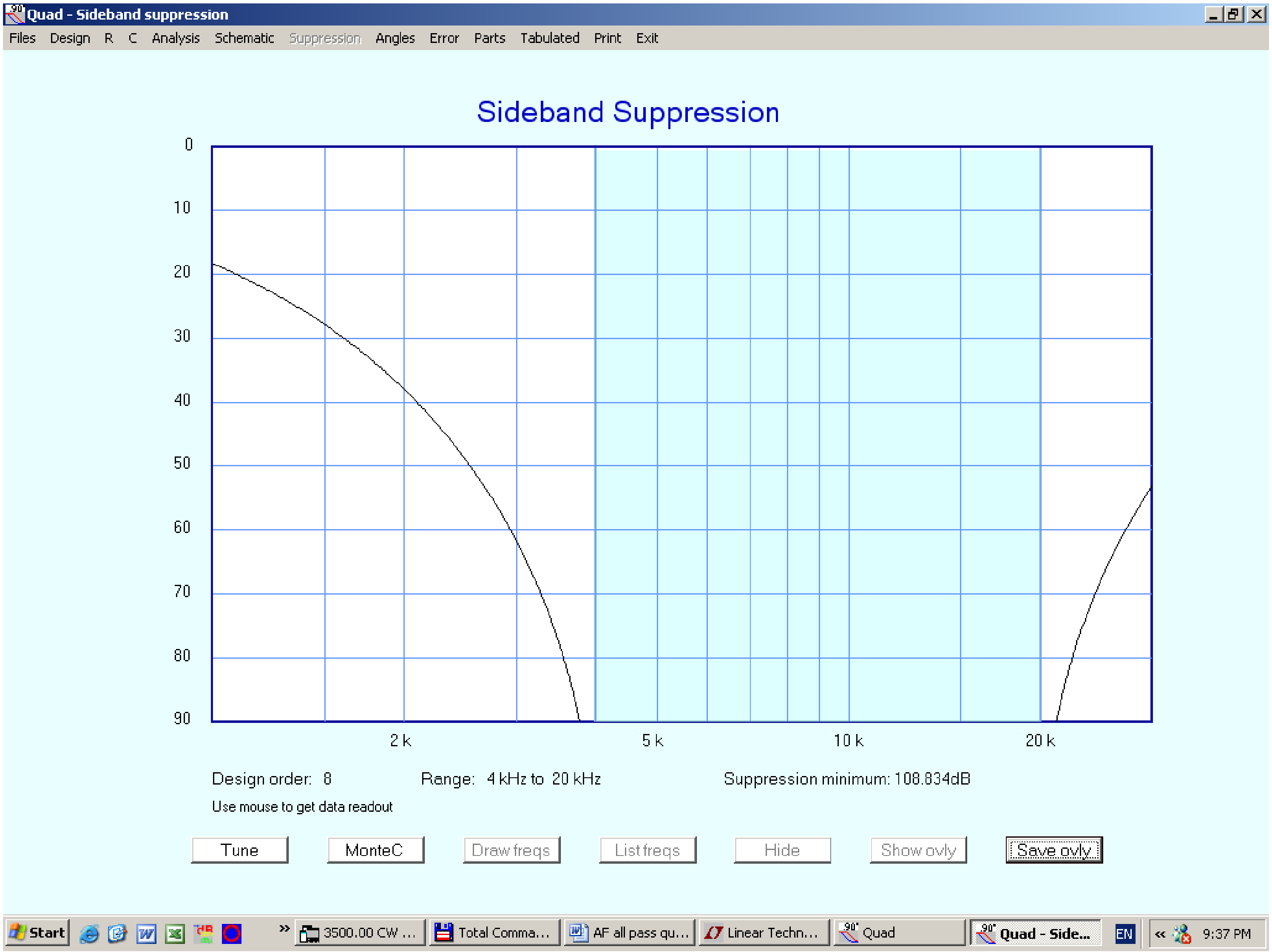

Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1
3
I
C1
0.01uF
C3
0.01uF
R1
371.037
R3
3.20061k
IN
2
4
Q
C2
0.01uF
C4
0.01uF
R2
1.31903k
R4
11.3781k
Order: 4
Frequency range: 4 kHz to 15 kHz
Sideband suppression design minimum: 57.7226dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are
locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Sche...
Linear Techno...
EN
9:17 PM

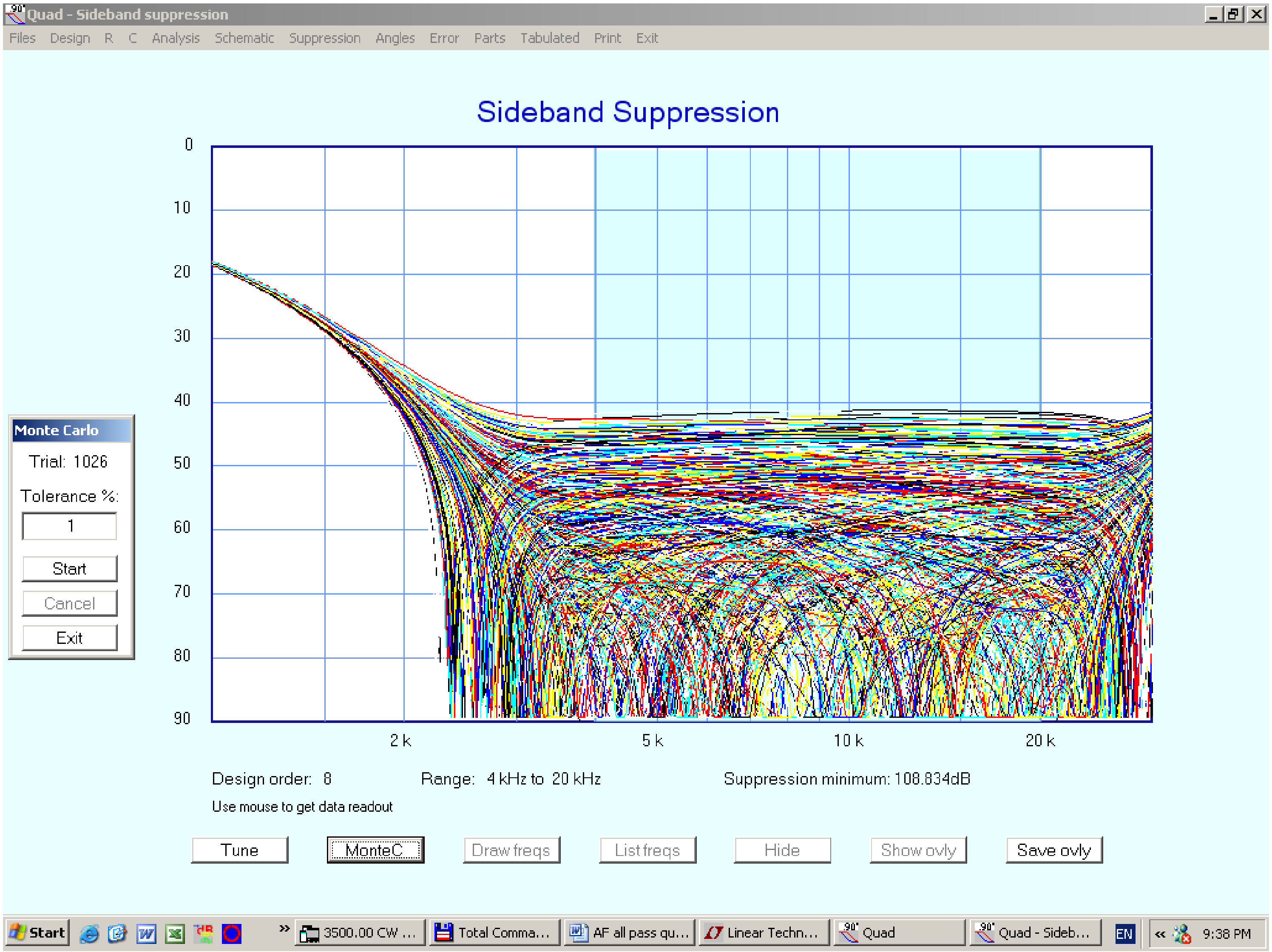

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
2 k
5 k
10 k
20 k
Design order: 4
Range: 4 kHz to 15 kHz
Suppression minimum: 57.7226dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Quad
Quad - Side...
Linear Techno...
EN
9:18 PM



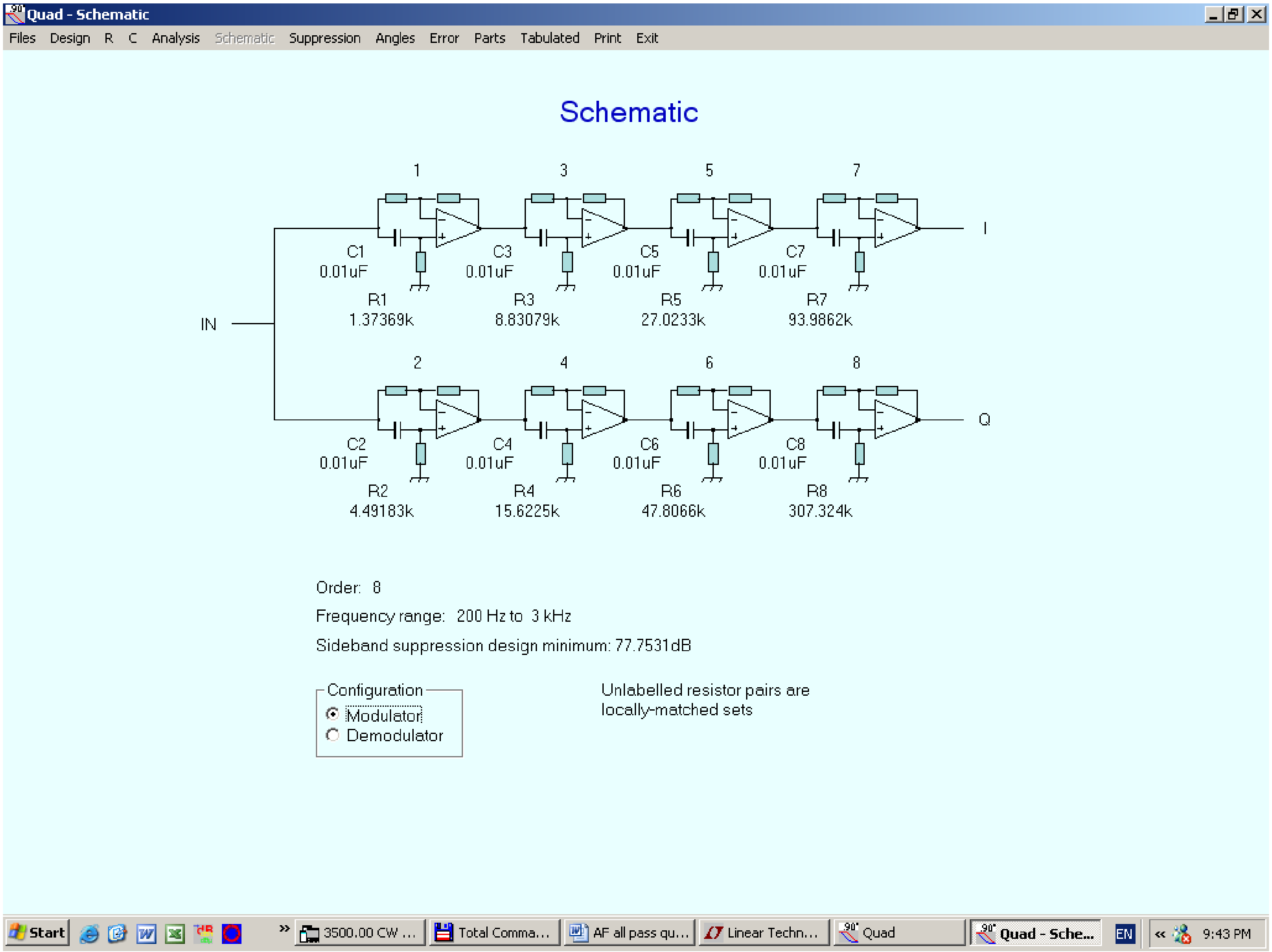
The same situation but with 8 order networks realized with two TL084 FET OP AMP.

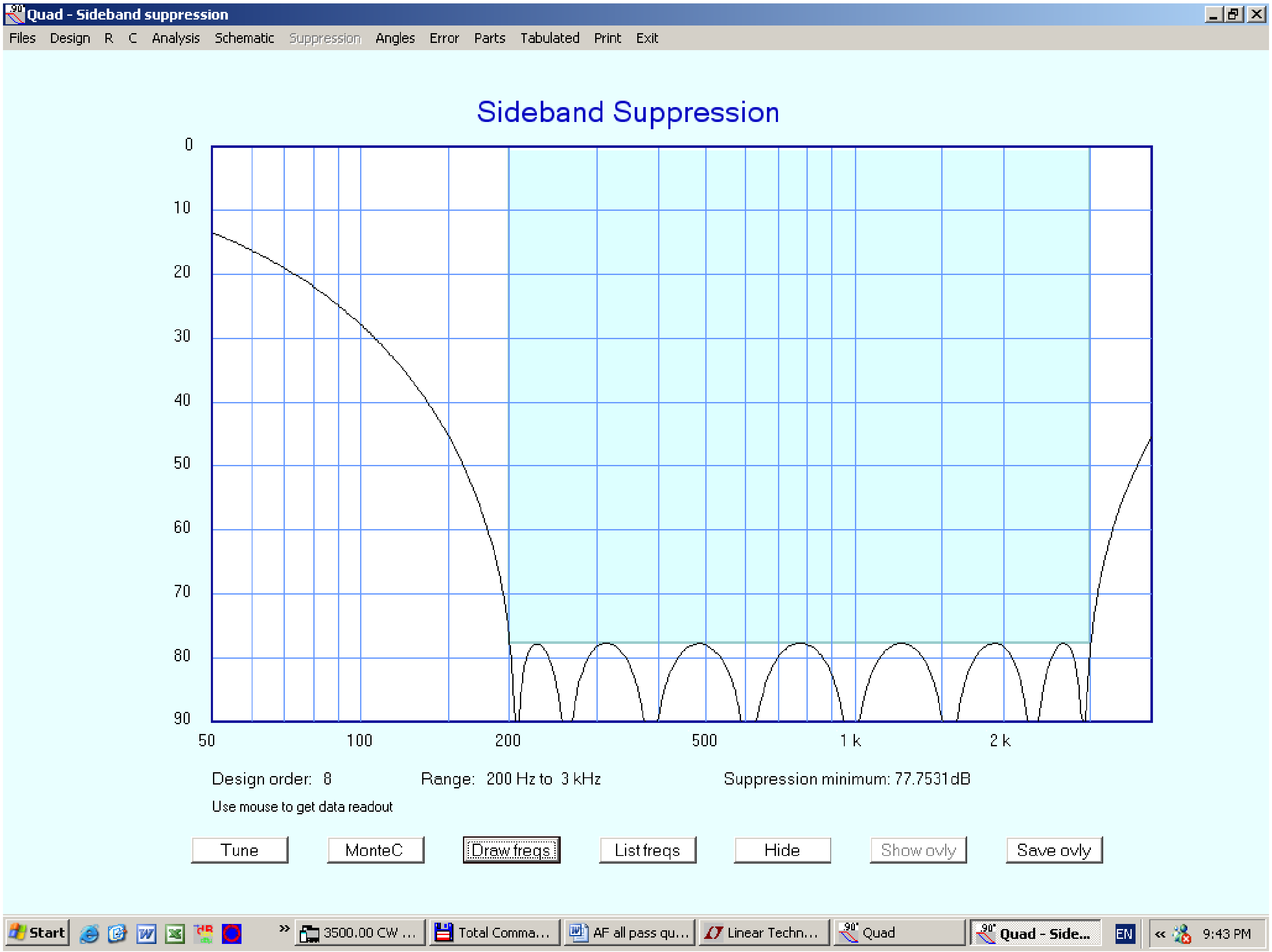

Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1
3
5
7
IN
I
C1 0.01uF
C3 0.01uF
C5 0.01uF
C7 0.01uF
R1 150.936
R3 874.018
R5 2.2335k
R7 6.65753k
2
4
6
8
Q
C2 0.01uF
C4 0.01uF
C6 0.01uF
C8 0.01uF
R2 475.593
R4 1.41763k
R6 3.62267k
R8 20.9775k
Order: 8
Frequency range: 4 kHz to 20 kHz
Sideband suppression design minimum: 108.834dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sche...
EN
9:36 PM

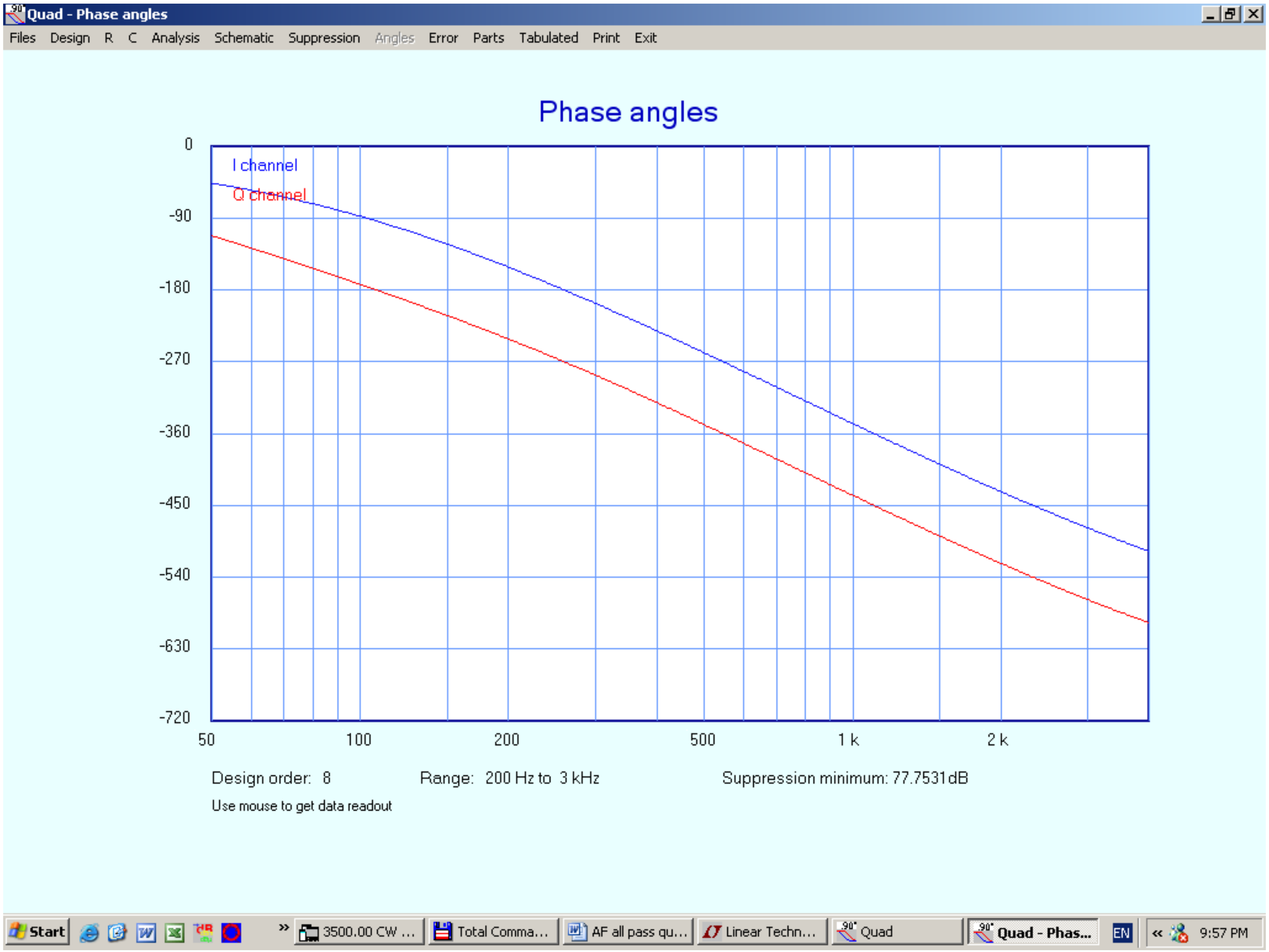

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
2 k
5 k
10 k
20 k
Design order: 8
Range: 4 kHz to 20 kHz
Suppression minimum: 108.834dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Side...
EN
9:37 PM

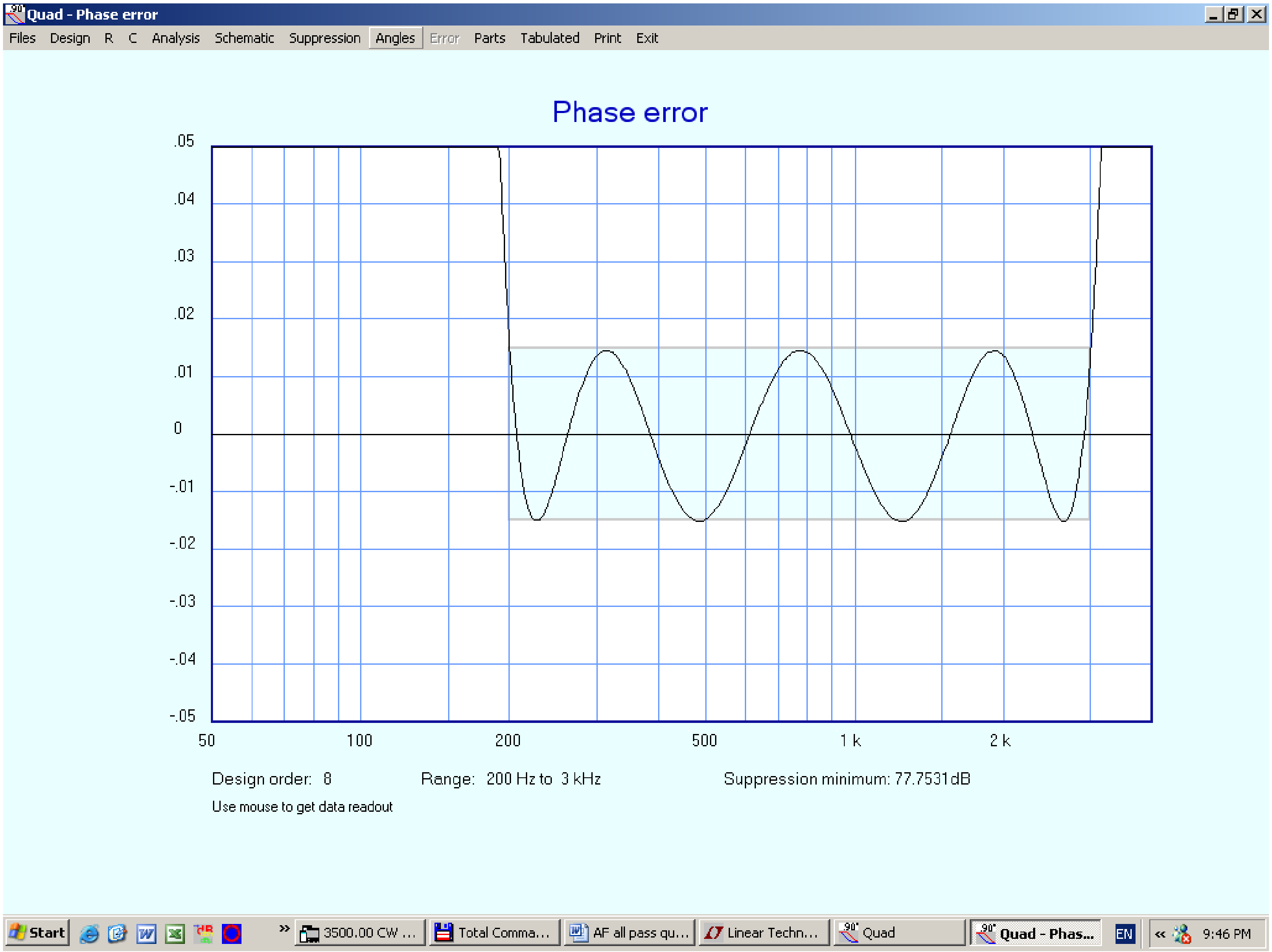


All pass network realization for SSB transmission audio frequency band between 200 Hz to 3 kHz and 8 order networks with 2 FET OP AMP TL084.

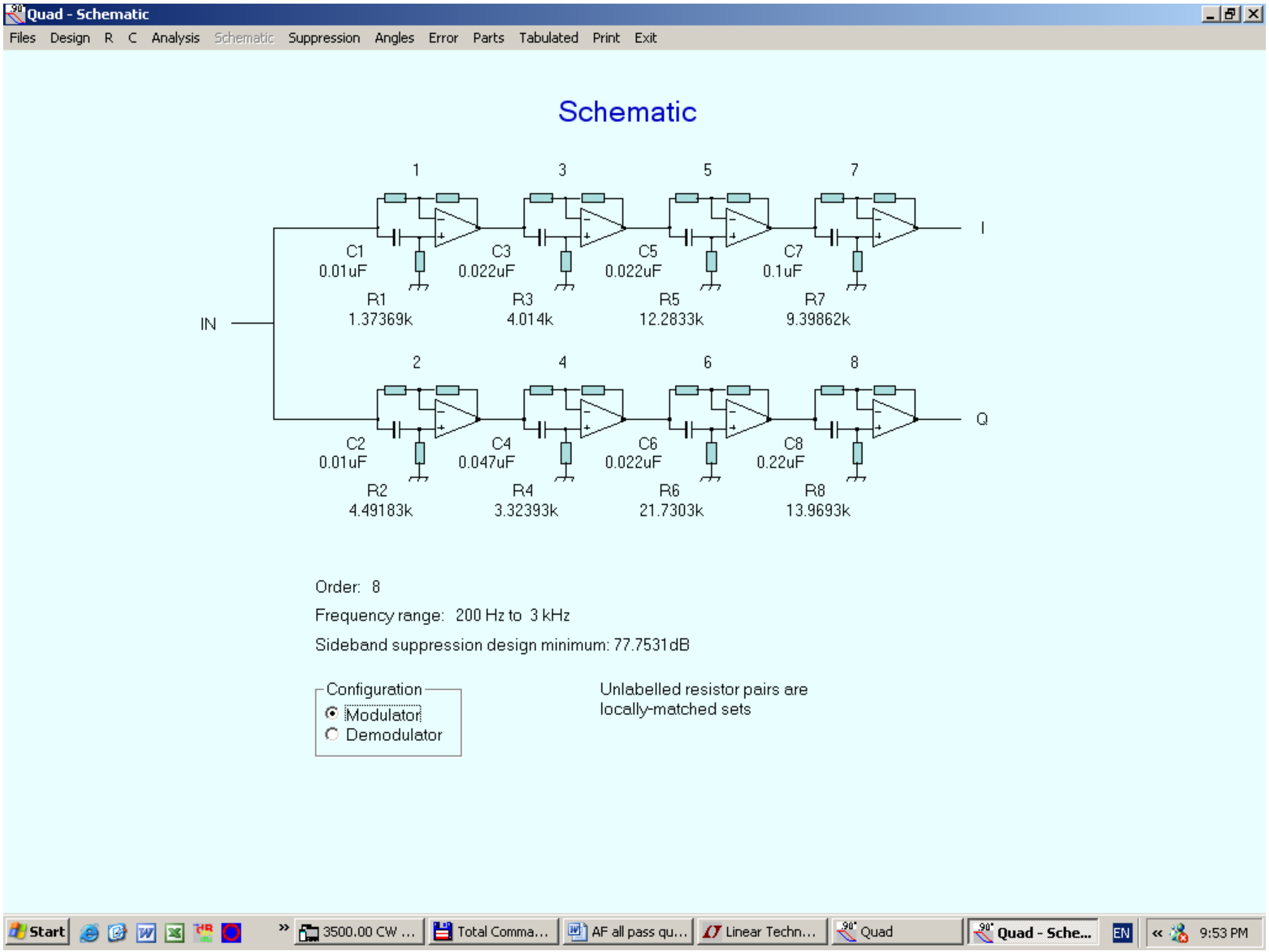

Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1
3
5
7
I
C1 0.01uF
C3 0.01uF
C5 0.01uF
C7 0.01uF
R1 1.37369k
R3 8.83079k
R5 27.0233k
R7 93.9862k
IN
2
4
6
8
Q
C2 0.01uF
C4 0.01uF
C6 0.01uF
C8 0.01uF
R2 4.49183k
R4 15.6225k
R6 47.8066k
R8 307.324k
Order: 8
Frequency range: 200 Hz to 3 kHz
Sideband suppression design minimum: 77.7531dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sche...
EN
9:43 PM


Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
50
100
200
500
1 k
2 k
Design order: 8
Range: 200 Hz to 3 kHz
Suppression minimum: 77.7531dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Side...
EN
9:43 PM

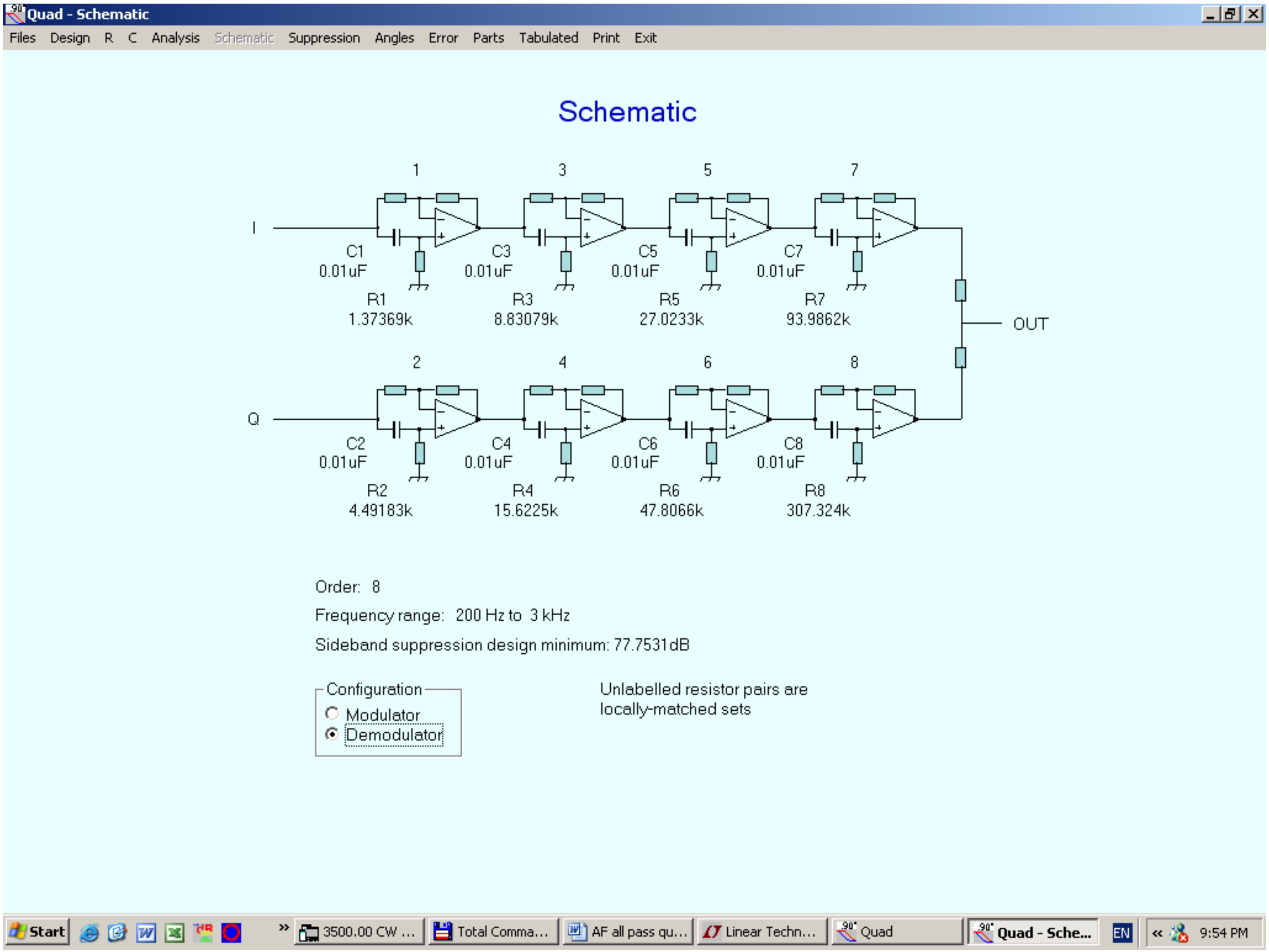

Quad - Phase angles
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Phase angles
I channel
Q channel
0
-90
-180
-270
-360
-450
-540
-630
-720
50
100
200
500
1 k
2 k
Design order: 8
Range: 200 Hz to 3 kHz
Suppression minimum: 77.7531dB
Use mouse to get data readout
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Phas...
EN
9:57 PM



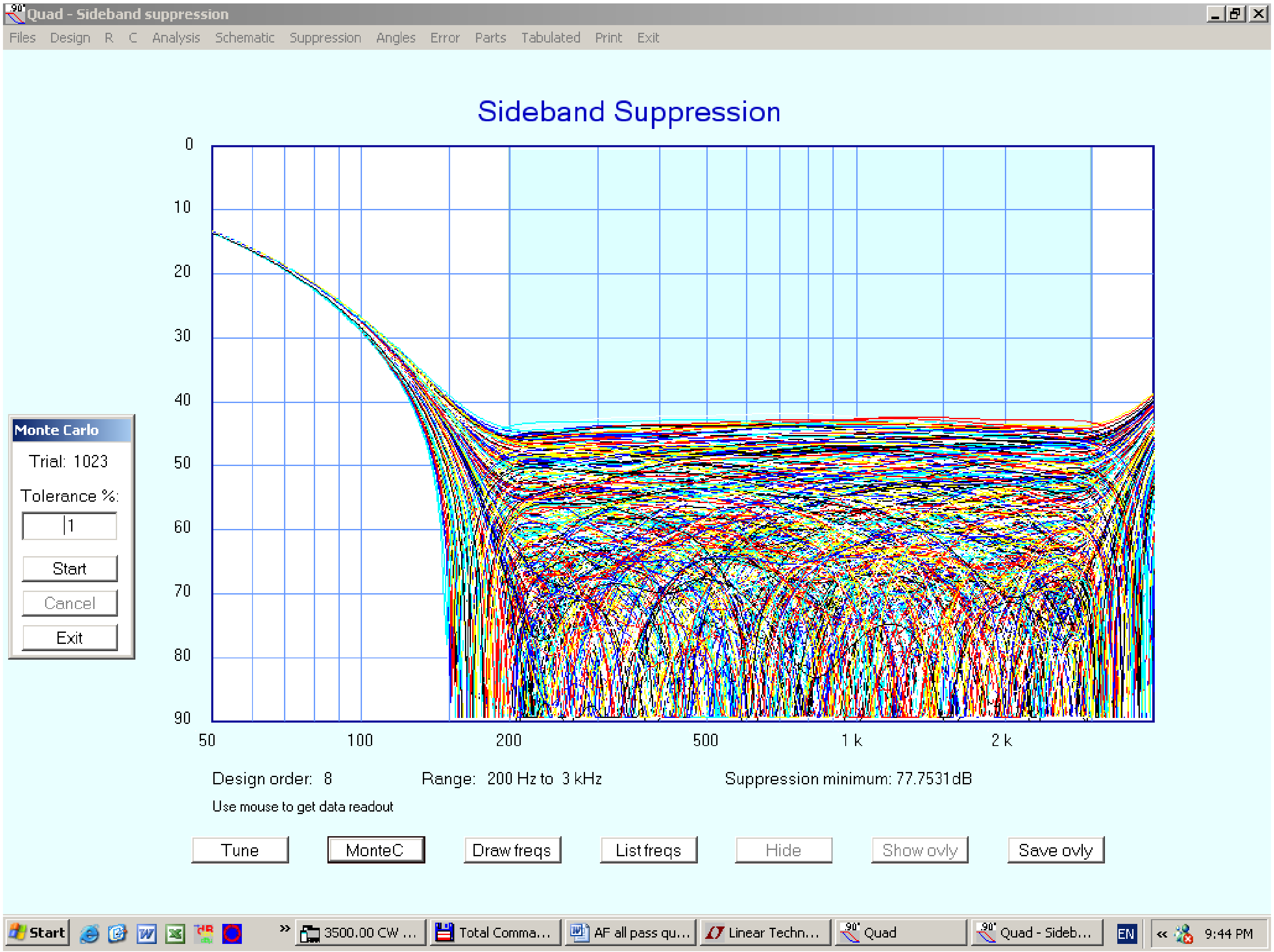
Alternative values for the all pass SSB network when the C capacitors are non equally values.

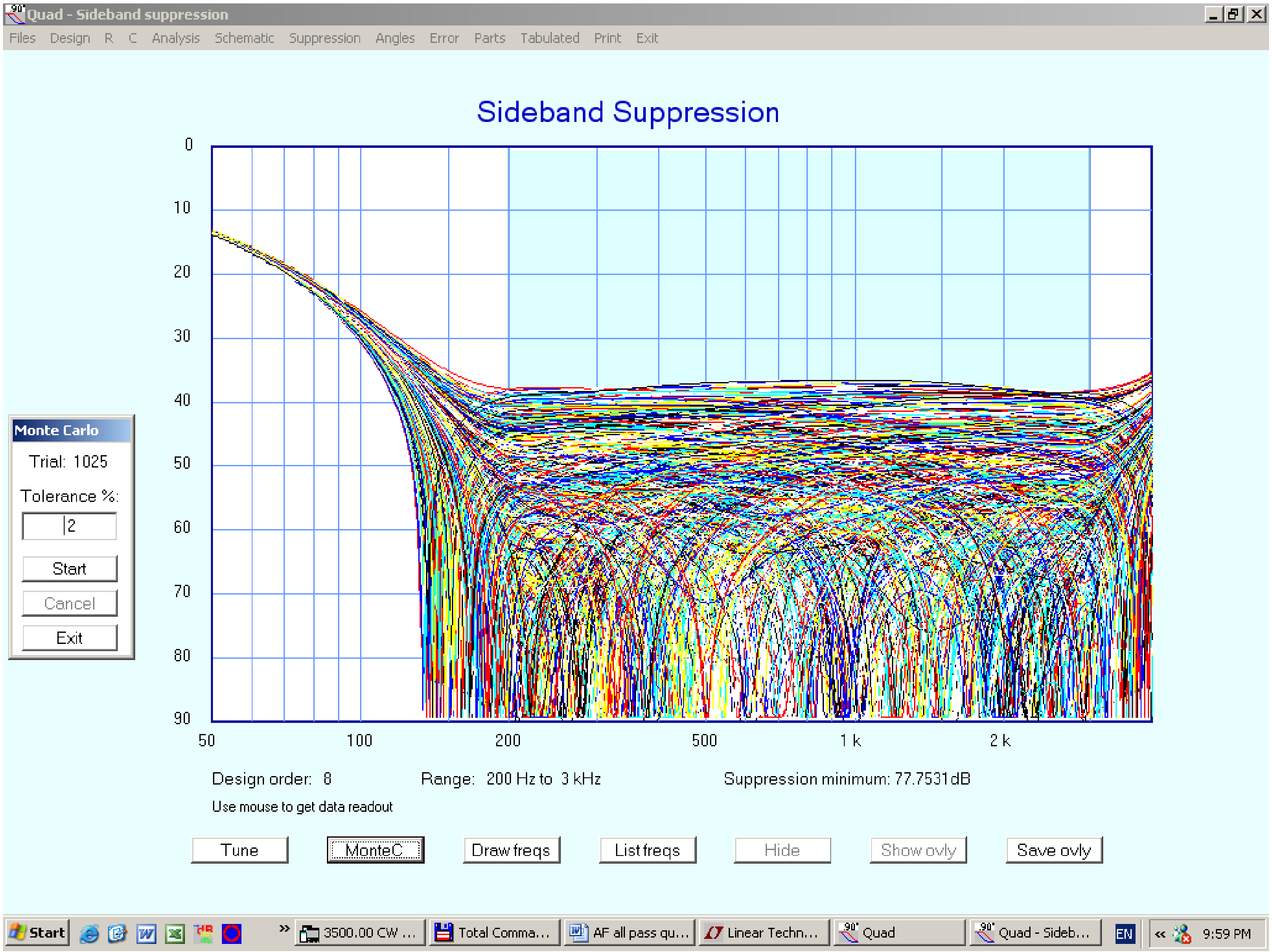


Schematics for the same network but in the demodulator circuit.

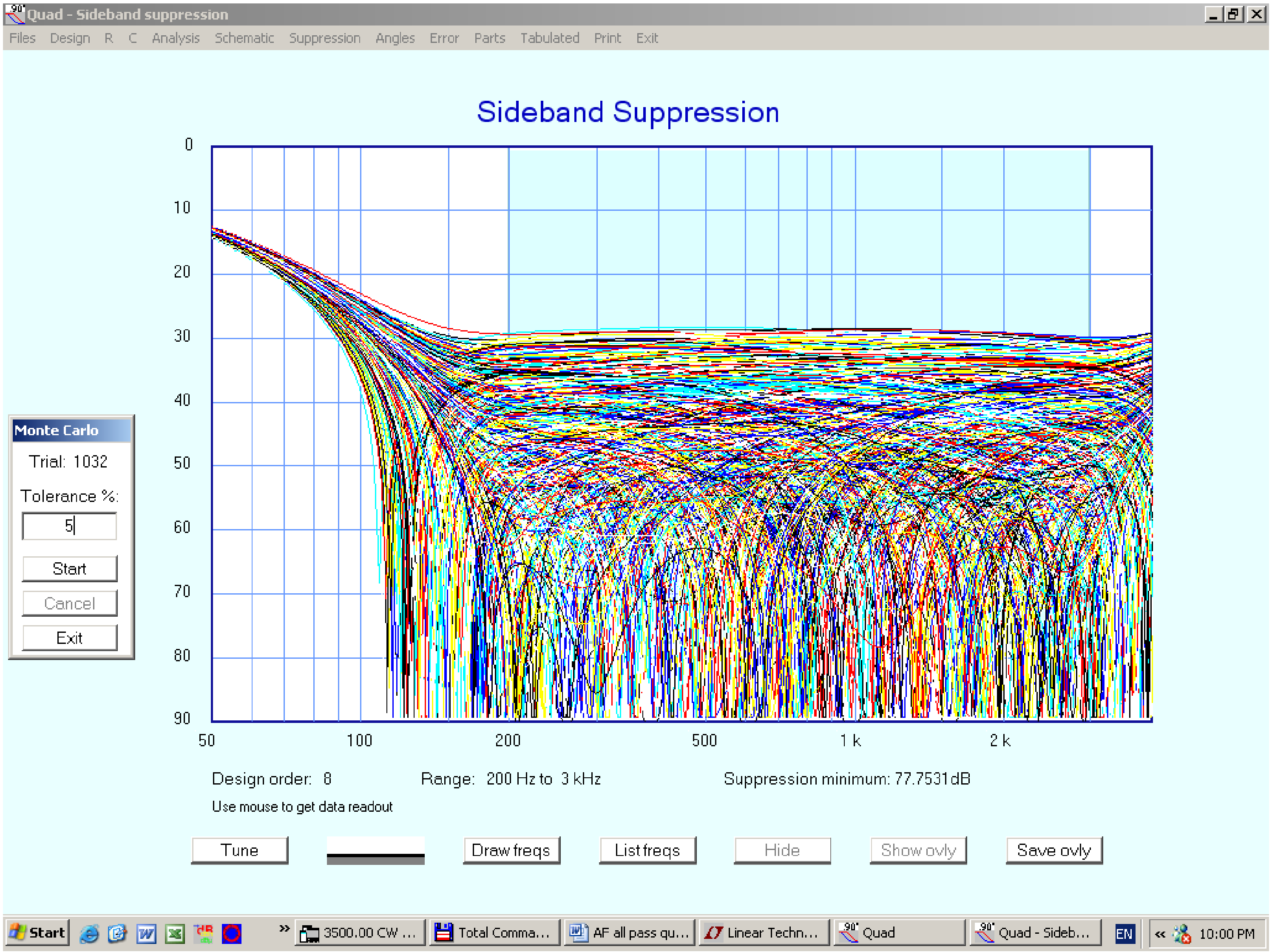


Component tolerances influence for the 1 %, 2 % and 5 % tolerance shows that final real results is unwanted sideband suppression which we can expecting from practical realization.

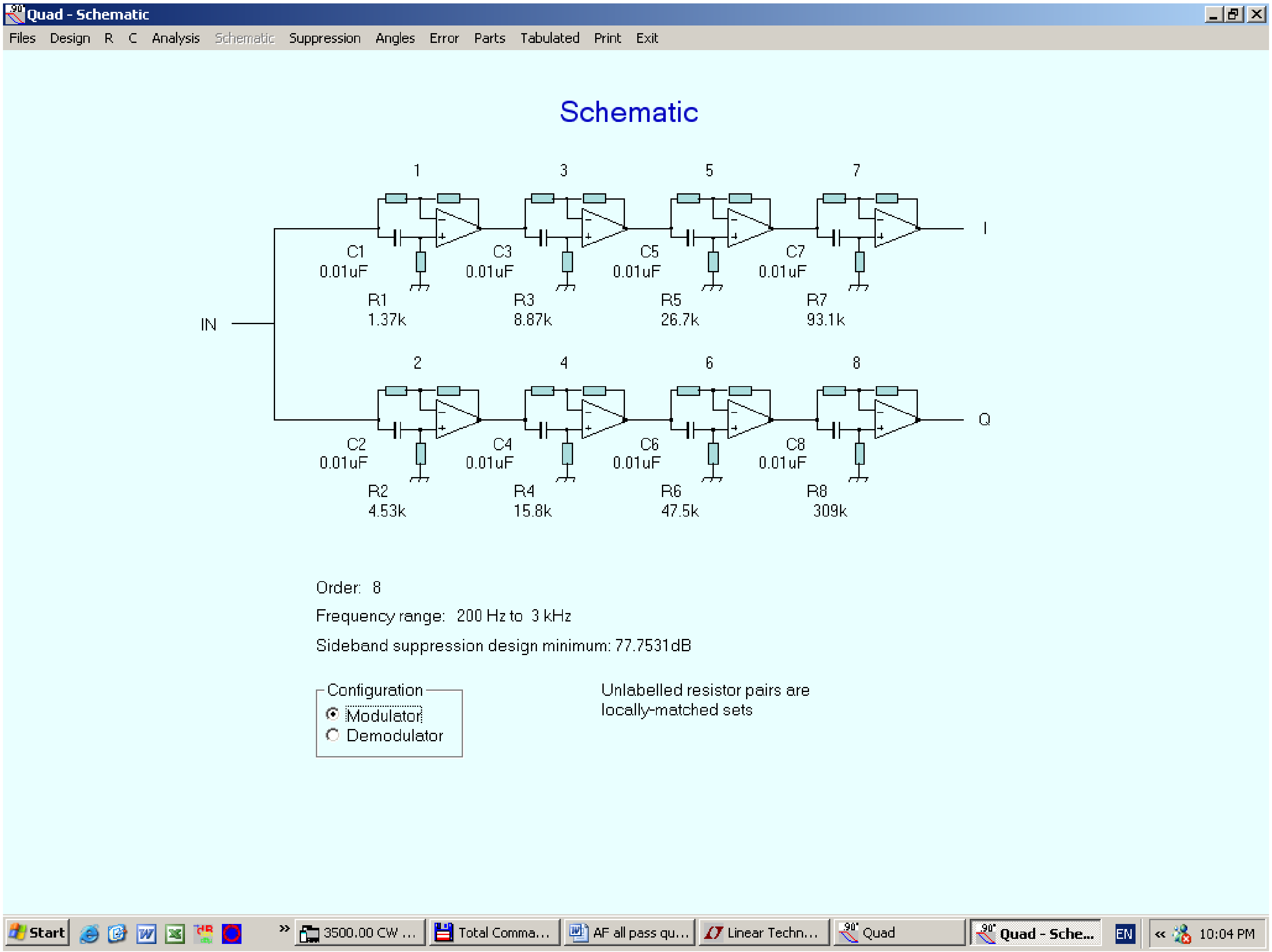

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
Monte Carlo
Trial: 1023
Tolerance %:
1
Start
Cancel
Exit
0
10
20
30
40
50
60
70
80
90
50
100
200
500
1 k
2 k
Design order: 8
Range: 200 Hz to 3 kHz
Suppression minimum: 77.7531dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sideb...
EN
9:44 PM

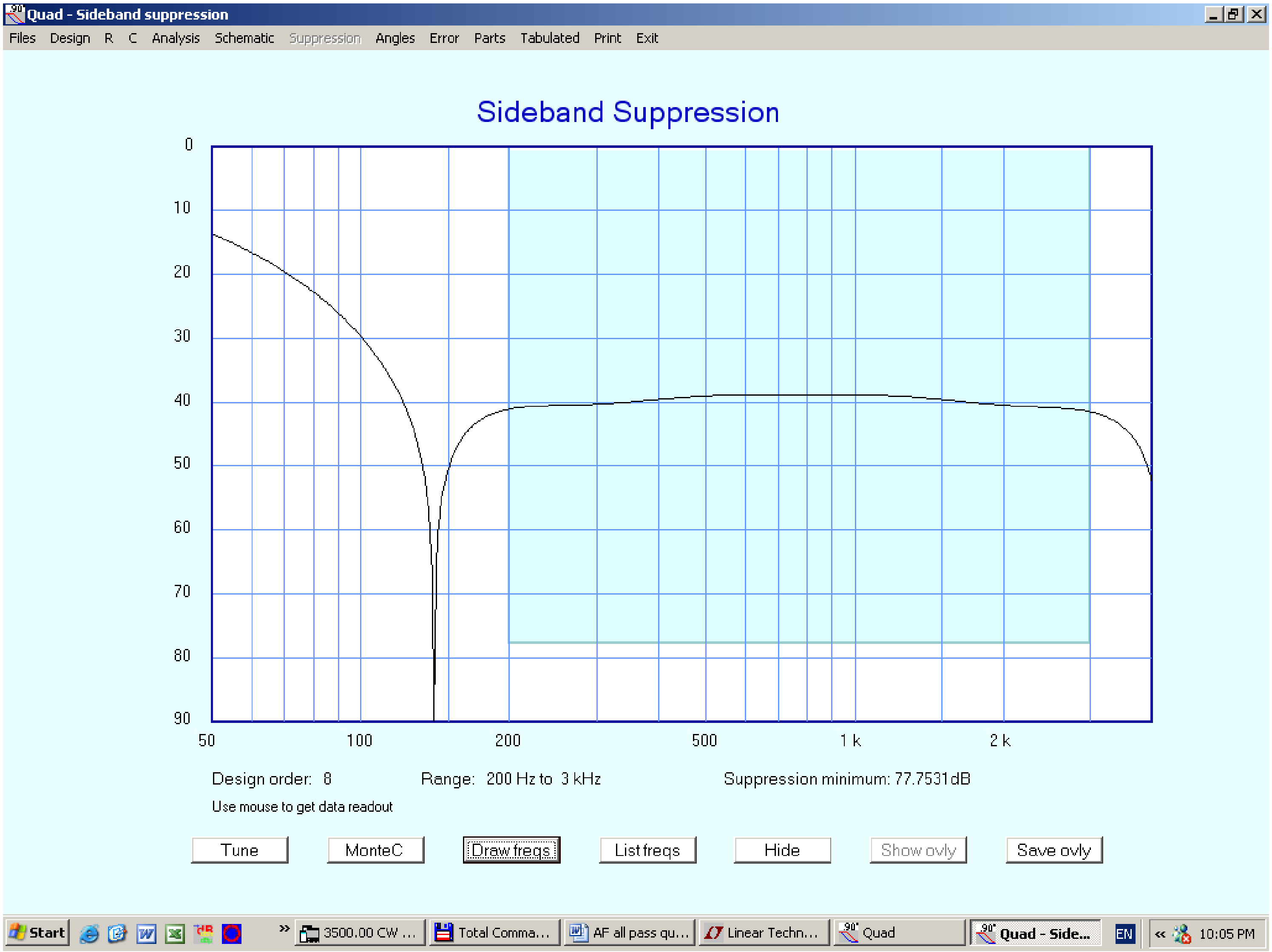


Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
Monte Carlo
Trial: 1025
Tolerance %:
2
Start
Cancel
Exit
0
10
20
30
40
50
60
70
80
90
50
100
200
500
1 k
2 k
Design order: 8
Range: 200 Hz to 3 kHz
Suppression minimum: 77.7531dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sideb...
EN
9:59 PM

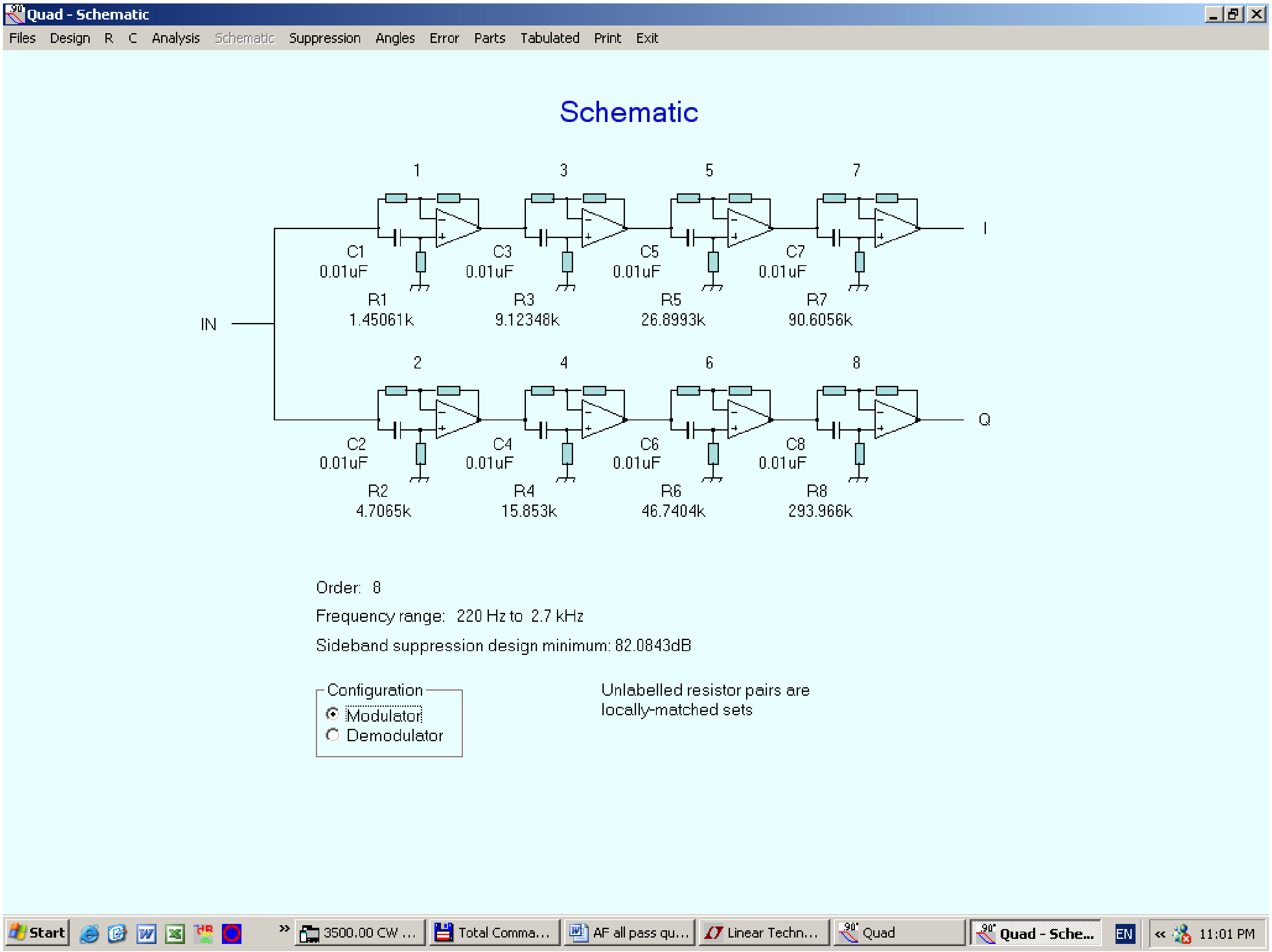


All pass SSB phase shifter realization with standard real 1% R and C components

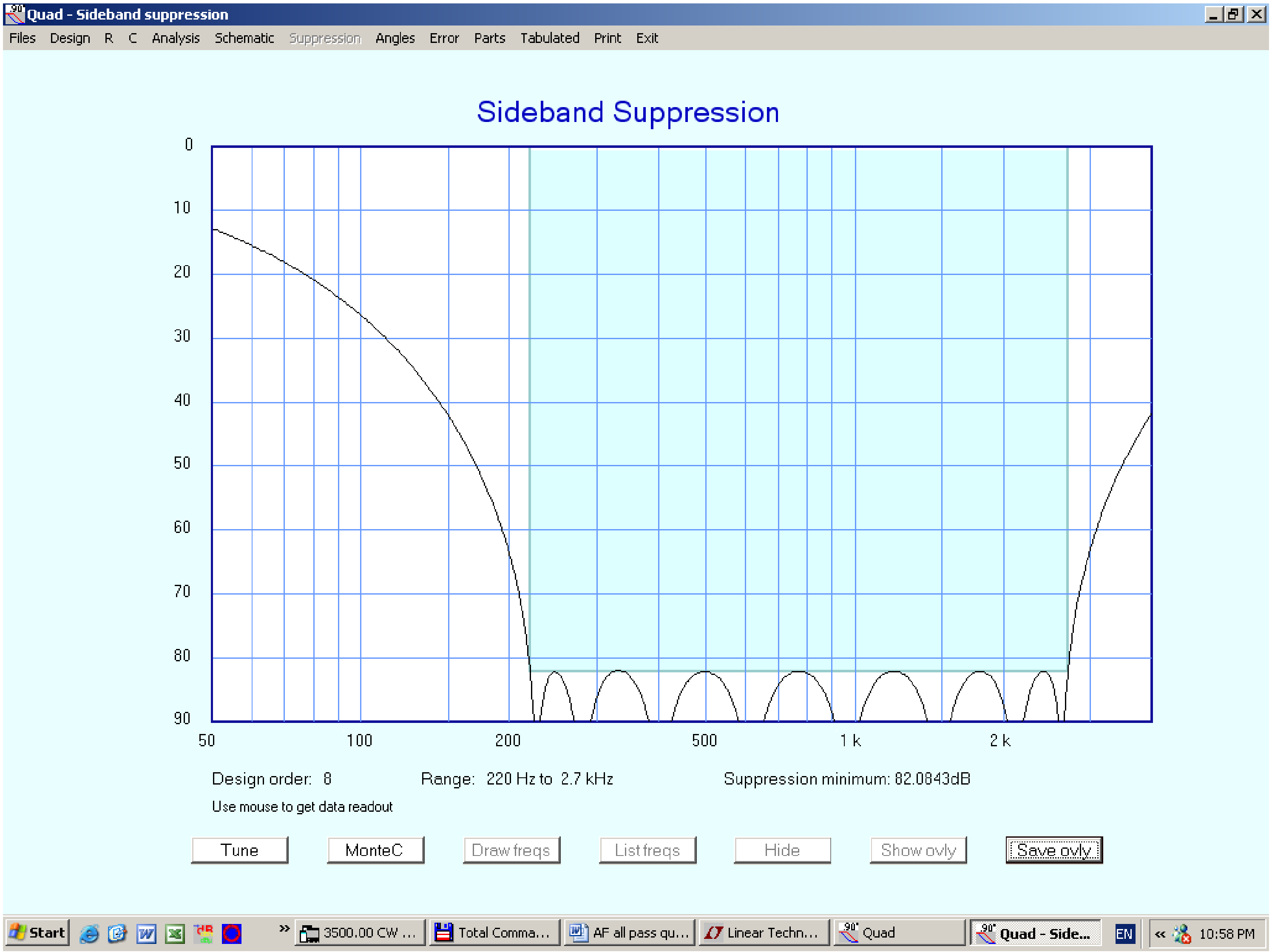

Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1 3 5 7
C1 0.01uF C3 0.01uF C5 0.01uF C7 0.01uF
R1 1.37k R3 8.87k R5 26.7k R7 93.1k
I
IN
2 4 6 8
C2 0.01uF C4 0.01uF C6 0.01uF C8 0.01uF
R2 4.53k R4 15.8k R6 47.5k R8 309k
Q
Order: 8
Frequency range: 200 Hz to 3 kHz
Sideband suppression design minimum: 77.7531dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are
locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sche...
EN
10:04 PM



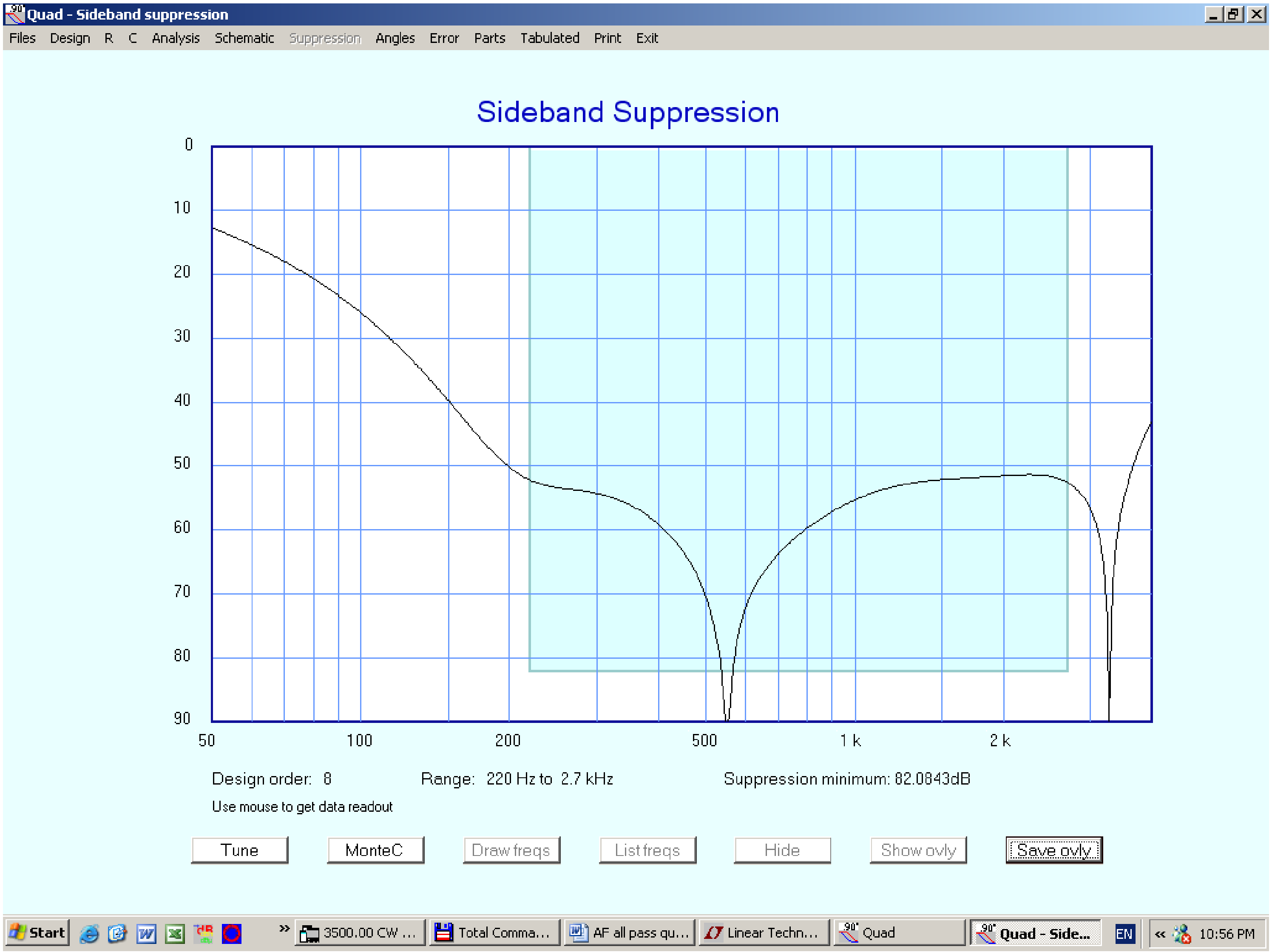
Alternative design with little changed AF corners and with optimization to the standard R and C values. First is done ideal and then real realization result.

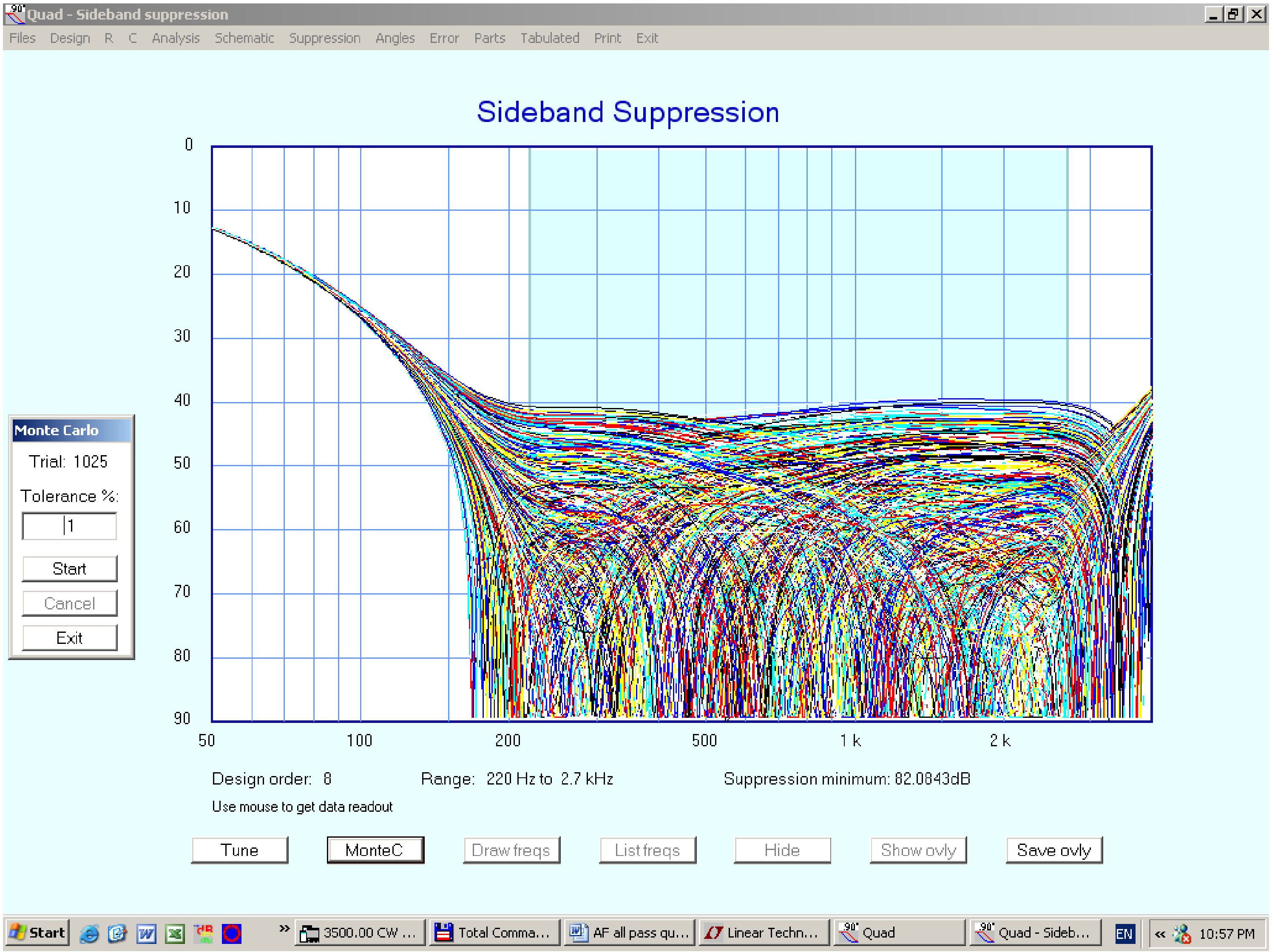


Quad - Schematic
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Schematic
1 3 5 7
C1 0.01uF
C3 0.01uF
C5 0.01uF
C7 0.01uF
R1 1.45061k
R3 9.12348k
R5 26.8993k
R7 90.6056k
IN
I
2 4 6 8
C2 0.01uF
C4 0.01uF
C6 0.01uF
C8 0.01uF
R2 4.7065k
R4 15.853k
R6 46.7404k
R8 293.966k
Q
Order: 8
Frequency range: 220 Hz to 2.7 kHz
Sideband suppression design minimum: 82.0843dB
Configuration
Modulator
Demodulator
Unlabelled resistor pairs are locally-matched sets
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Sche...
EN
11:01 PM



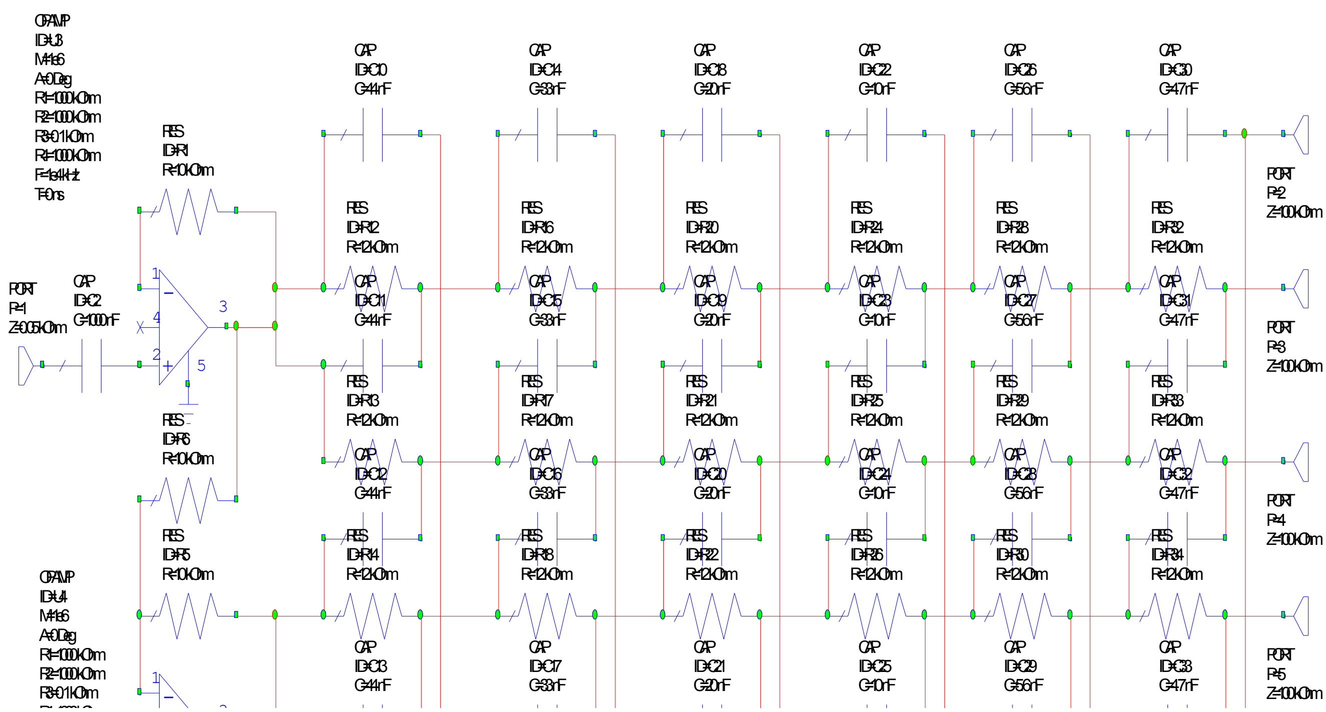
Sideband suppression with standard 1% components and their distribution around nominal values inside show they have influence to the final result.

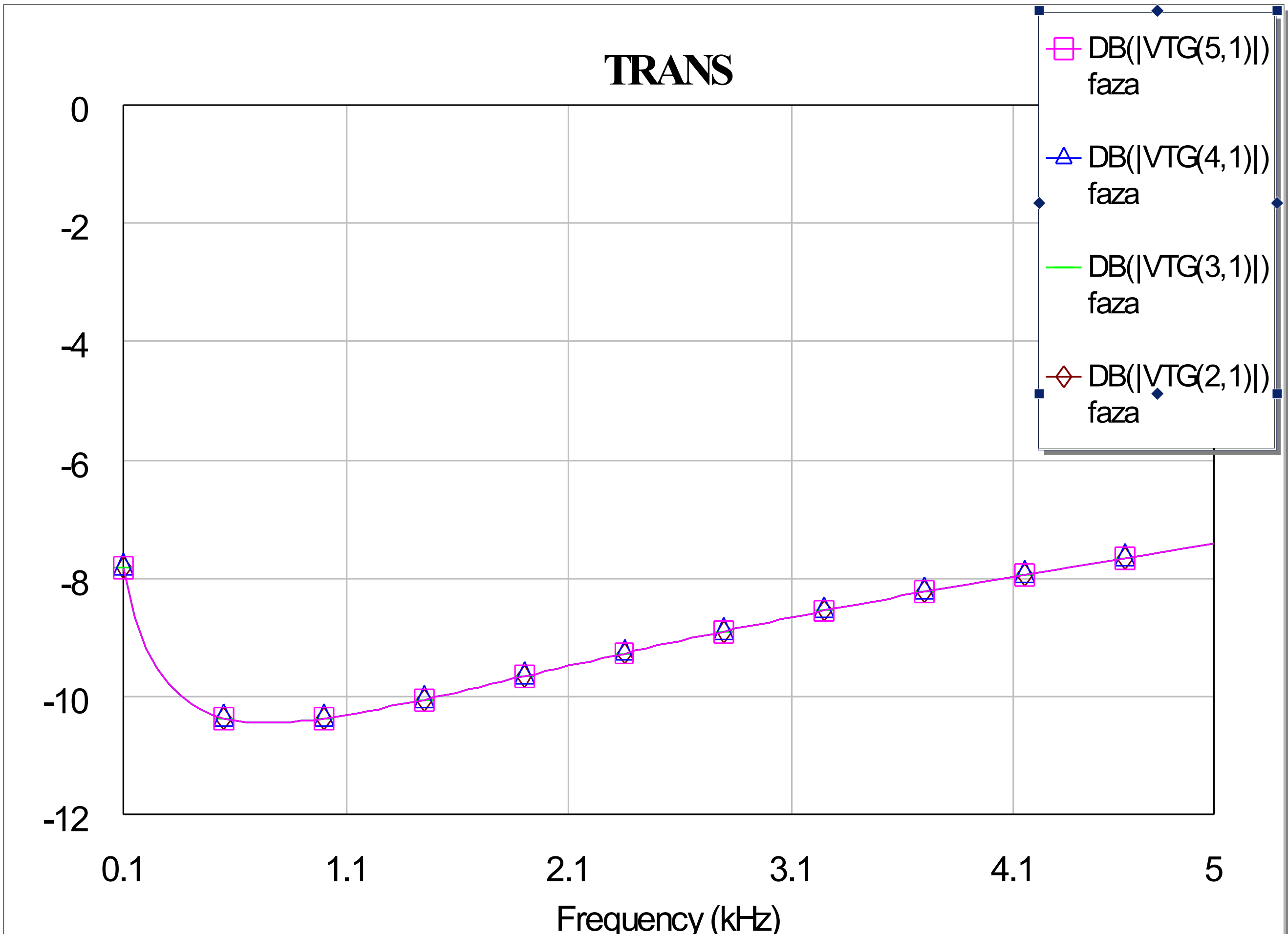

Quad - Sideband suppression
Files Design R C Analysis Schematic Suppression Angles Error Parts Tabulated Print Exit
Sideband Suppression
0
10
20
30
40
50
60
70
80
90
50
100
200
500
1 k
2 k
Design order: 8
Range: 220 Hz to 2.7 kHz
Suppression minimum: 82.0843dB
Use mouse to get data readout
Tune
MonteC
Draw freqs
List freqs
Hide
Show ovly
Save ovly
Start
3500.00 CW ...
Total Comma...
AF all pass qu...
Linear Techn...
Quad
Quad - Side...
EN
10:56 PM



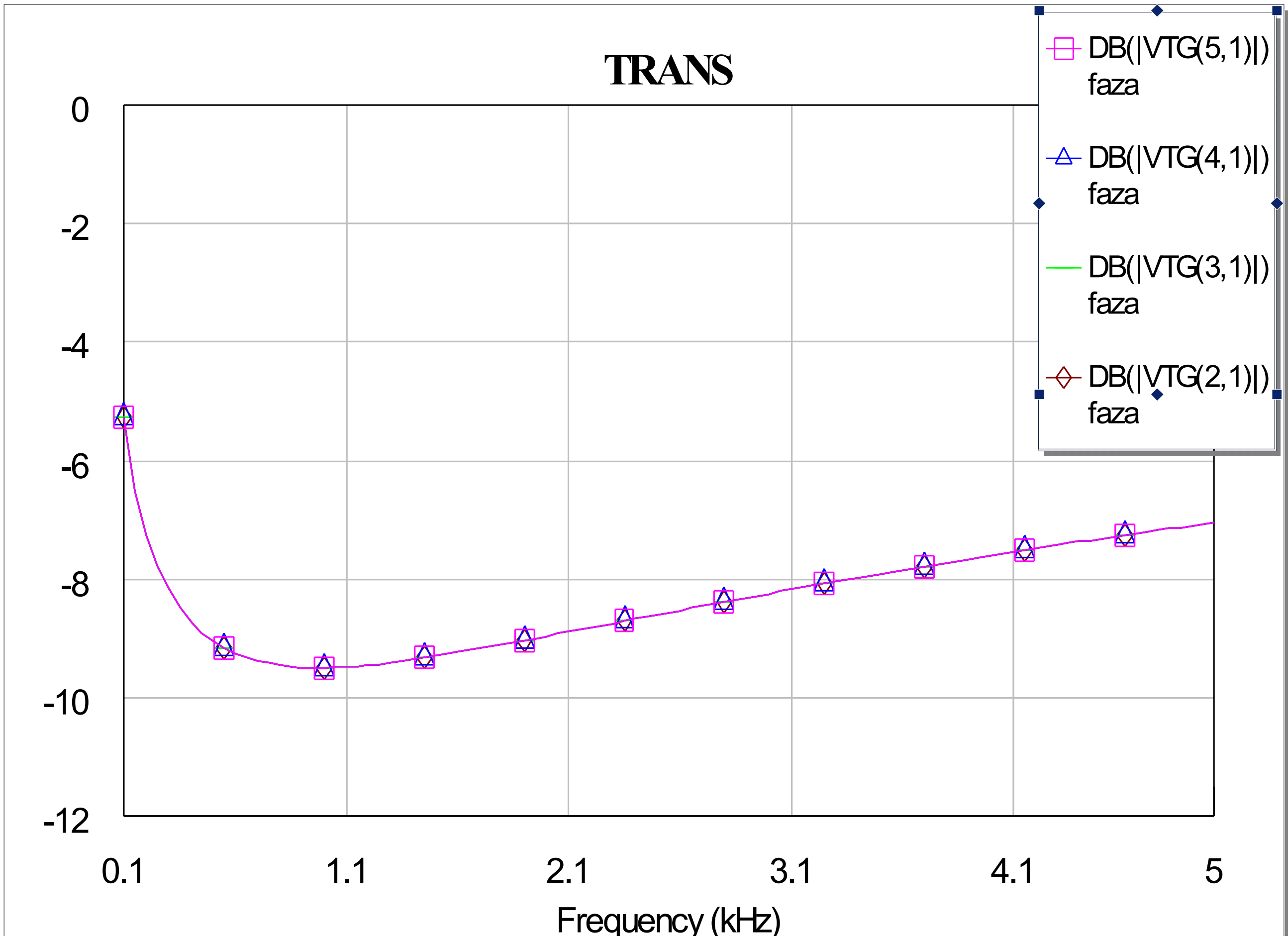
An all pass phase shift network realization for SSB work, schematic and PCB which I was used in test are down in the text. It is very important to lower gain all pass network outside wanted bandwidth practically we have to make attenuation to obtain stabile network work at the frequencies over 0.5 MHz typically. This behavior was observed during simulation in freeware SPICE CAD from Linear Technology LTSpice www.linear.com and in the practical realization.All adjustment are done with DMM (digital multimeter) without built in OP AMP inside PCB all pass phase shifter. To achieve wanted tolerances all components are measured and than they had been selected and chosen to achieve nominal values with parallel combination 2 capacitors (typical accuracy is better than 1 %) .All resistors are serial combination of fixed resistor and trim pot. They ware measured and adjusted with trim pots to wanted values. Next step in realization is inserting OP AMPs. OP AMPs ware soldered and measuring at phase shifter done results better than worst case obtained with Monte Carlo simulation. A typical value was between 45-55 dB unwanted sideband suppression. Comparing this results with now very much favorite multiphase RC networks gave results in practical realization equal or better than with polyphase network one more thing polyphase network have relative big attenuation around 9-12 dB! .To be honest some additional work have to be done in realization to active all pass network and obtain good result but with help of ordinary DMM with C measurements possibility.

Down in text I made polyphase network simulation with 1% elements tolerances and all resistors are with next combination 24 x 12K, C= (22nF+22nF) x4, 33nFx4, (10nF+10nF) x4, 10nFx4, 5nF6x4 and 4nF7x4. 4 Outputs are terminated with 100K resistors which is necessary for summing. Pay attention for next observation that even if we terminate OP AMP with 10 MOhms loads we have still significant insertion loss, see diagrams below.



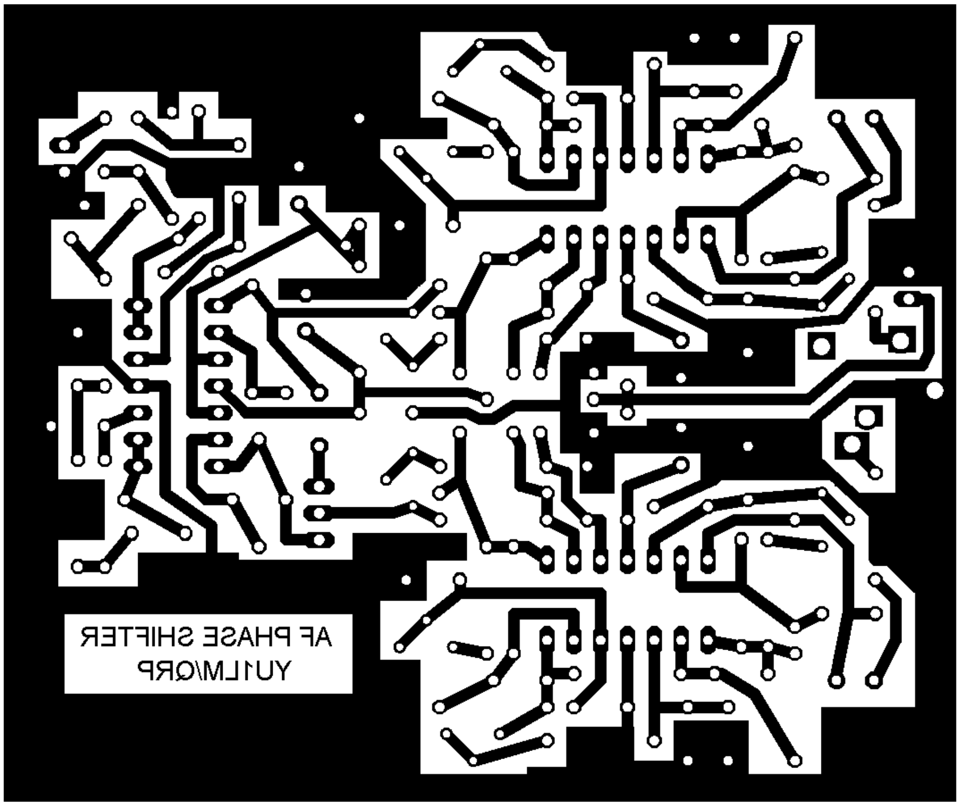


Polyphase network terminate with 100 k.loads

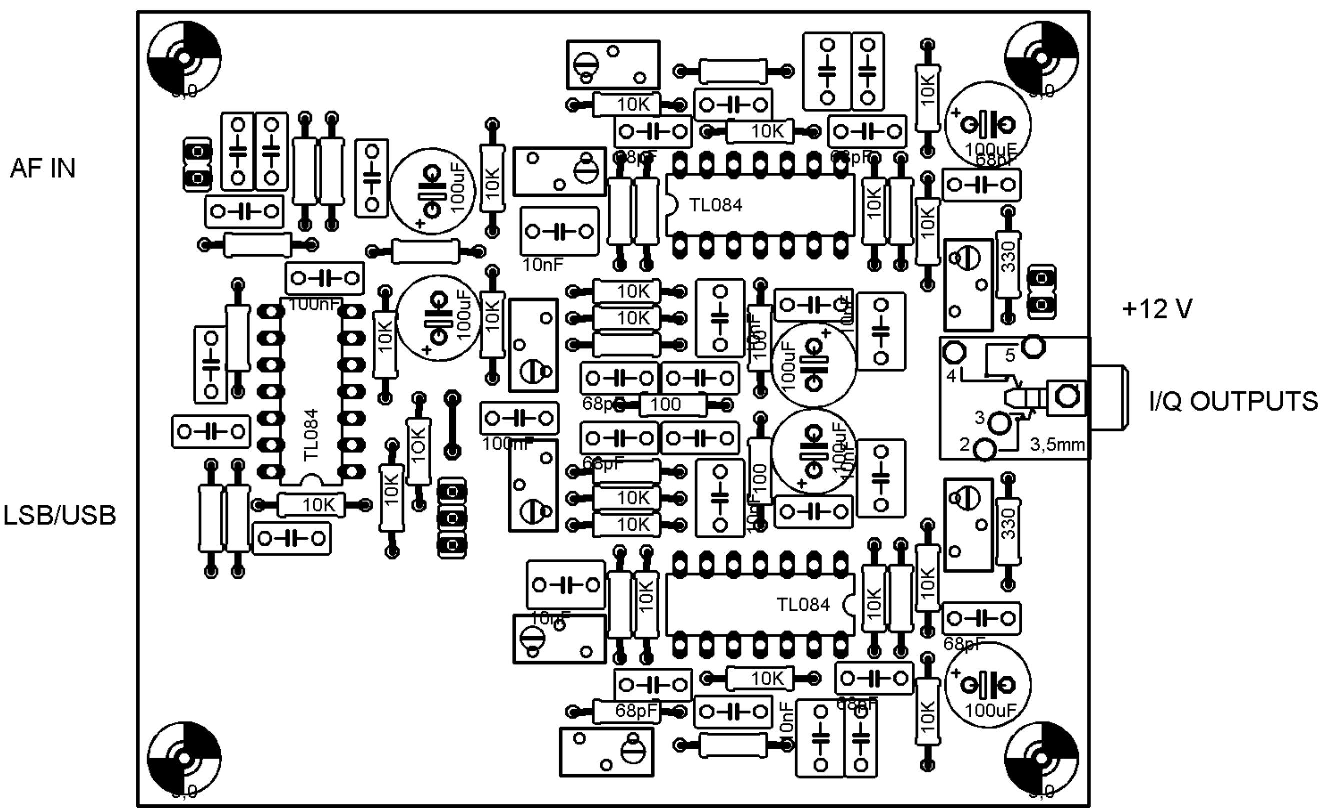


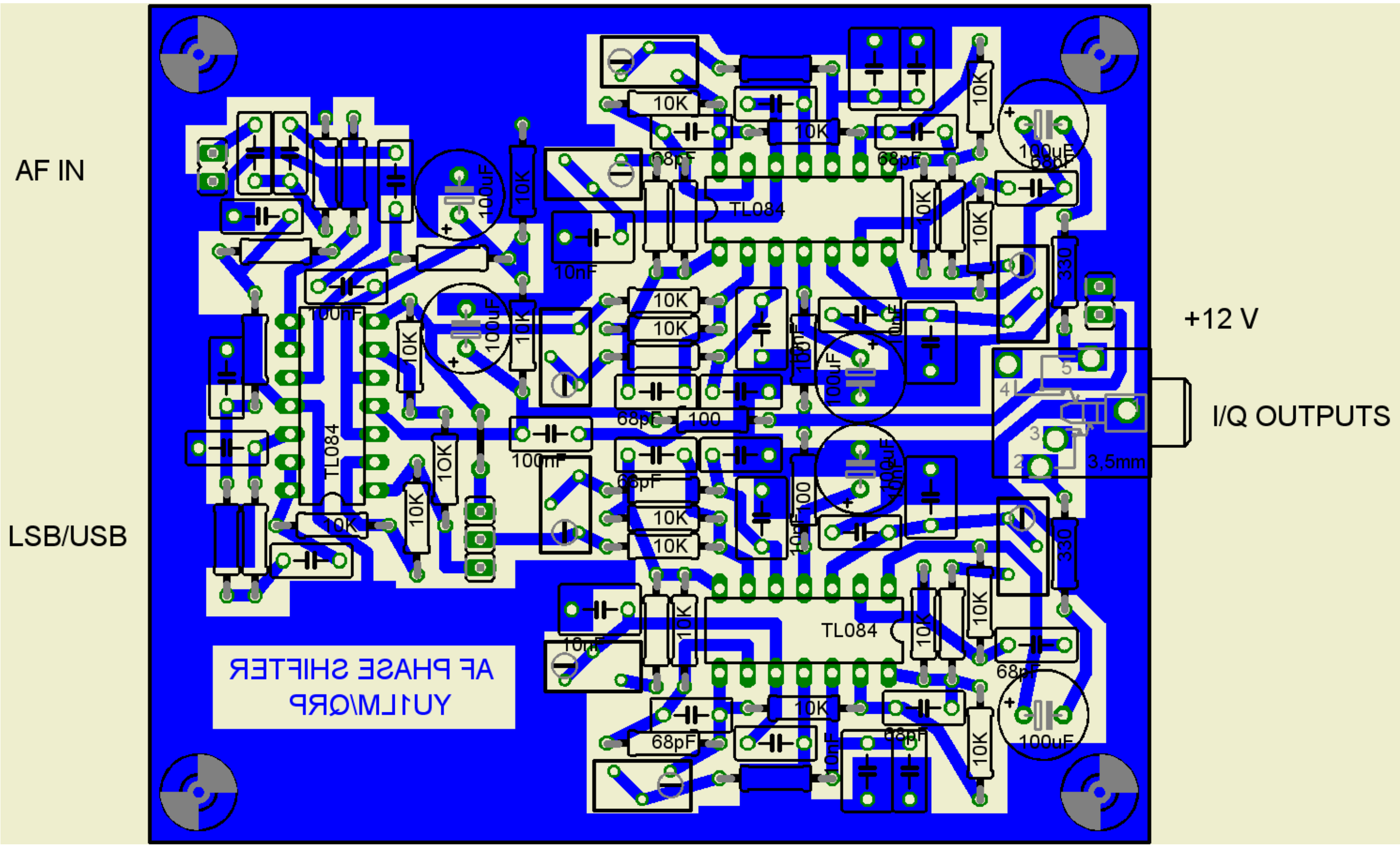
Polyphase network terminate with 10 Mohms unity gain buffer amplifier

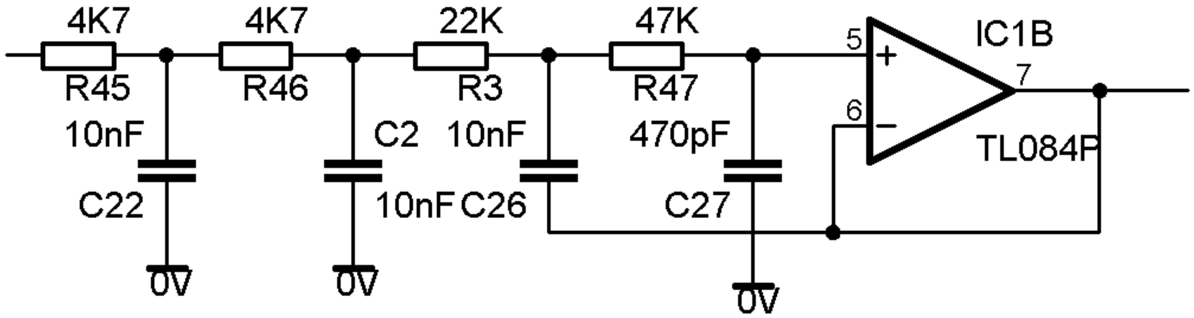
The PCB for audio phase shift network is drawn at the pictures down. PCB is designed for max 8 order audio phase shift network. Values for unmarked resistors and capacitors are from schematics UP or from your new design in QUAD and they are frequency dependable values. Exact values are from the CAD or schematics which you choose. At the circuit input, it is good to limit used bandwidth, see values and simulations for entrance down.. There is solution down how at same PCB mount lower order phase shift networks. Network order can be even and odd. The values determine can be easily determined with software QUAD. It is very important that to strictly obey my proposal how to connect unused OP AMP We don't like to obtain zero output in case of two equal signals are arriving at the + and – inputs of OP AMP. We don't like to test with this circuit CMRR from used OP AMP.



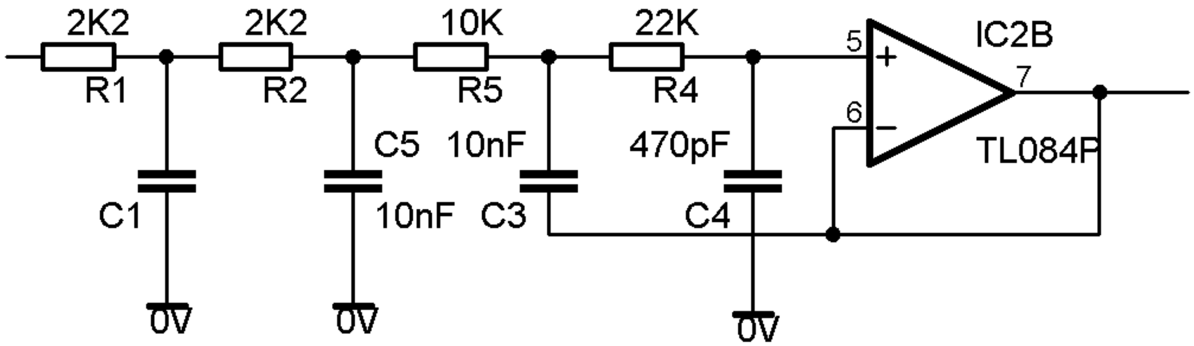
PCB size 90 x 75 mm



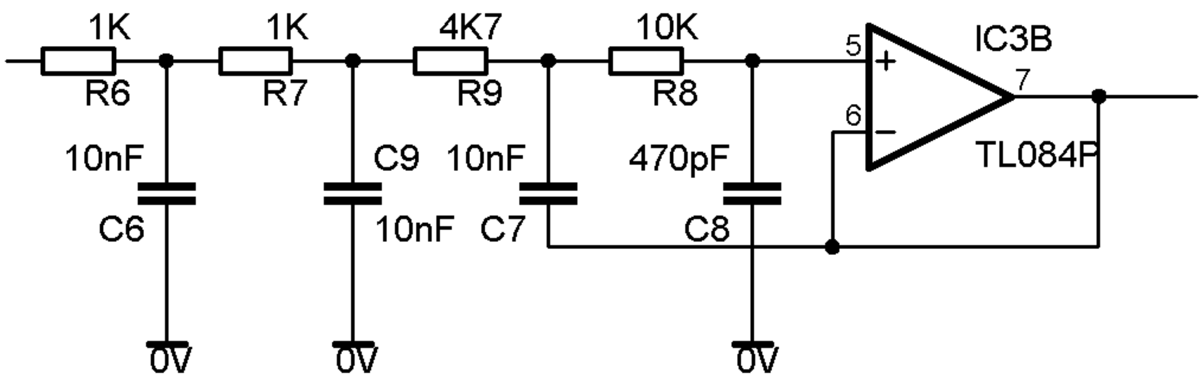

AF IN
LSB/USB
+12 V
I/Q OUTPUTS
TL084
10K
68pF
100uF
10nF
100nF
100
330
3,5mm



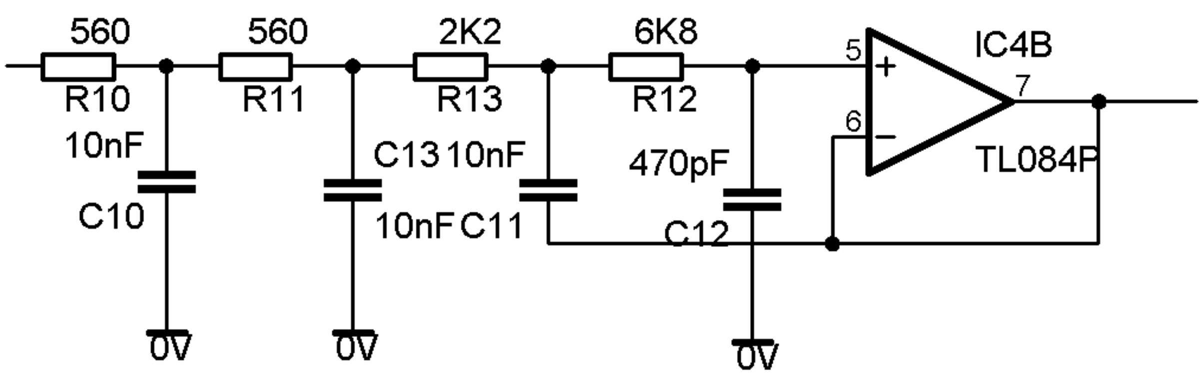
LOW PASS 2.2 kHz



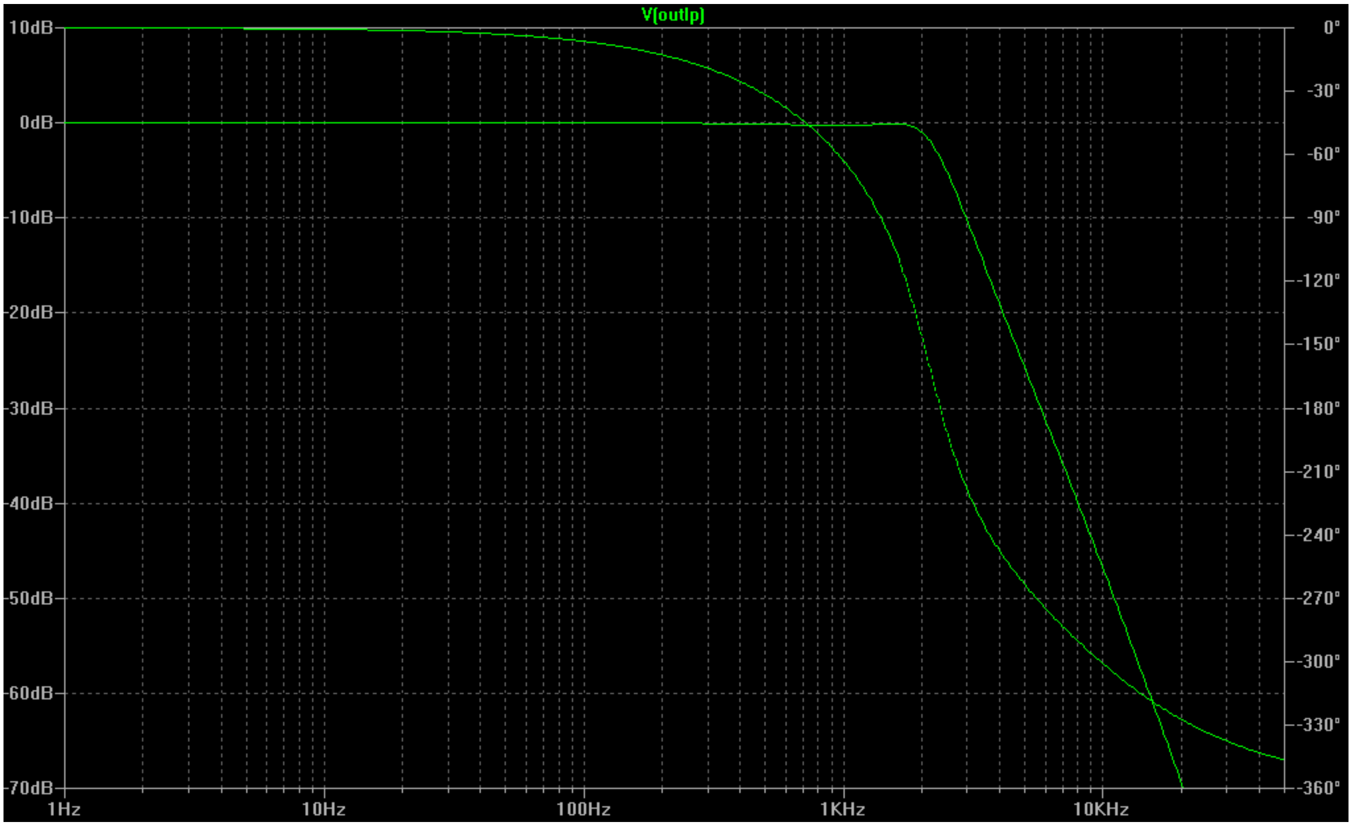
LOW PASS 3.3 kHz

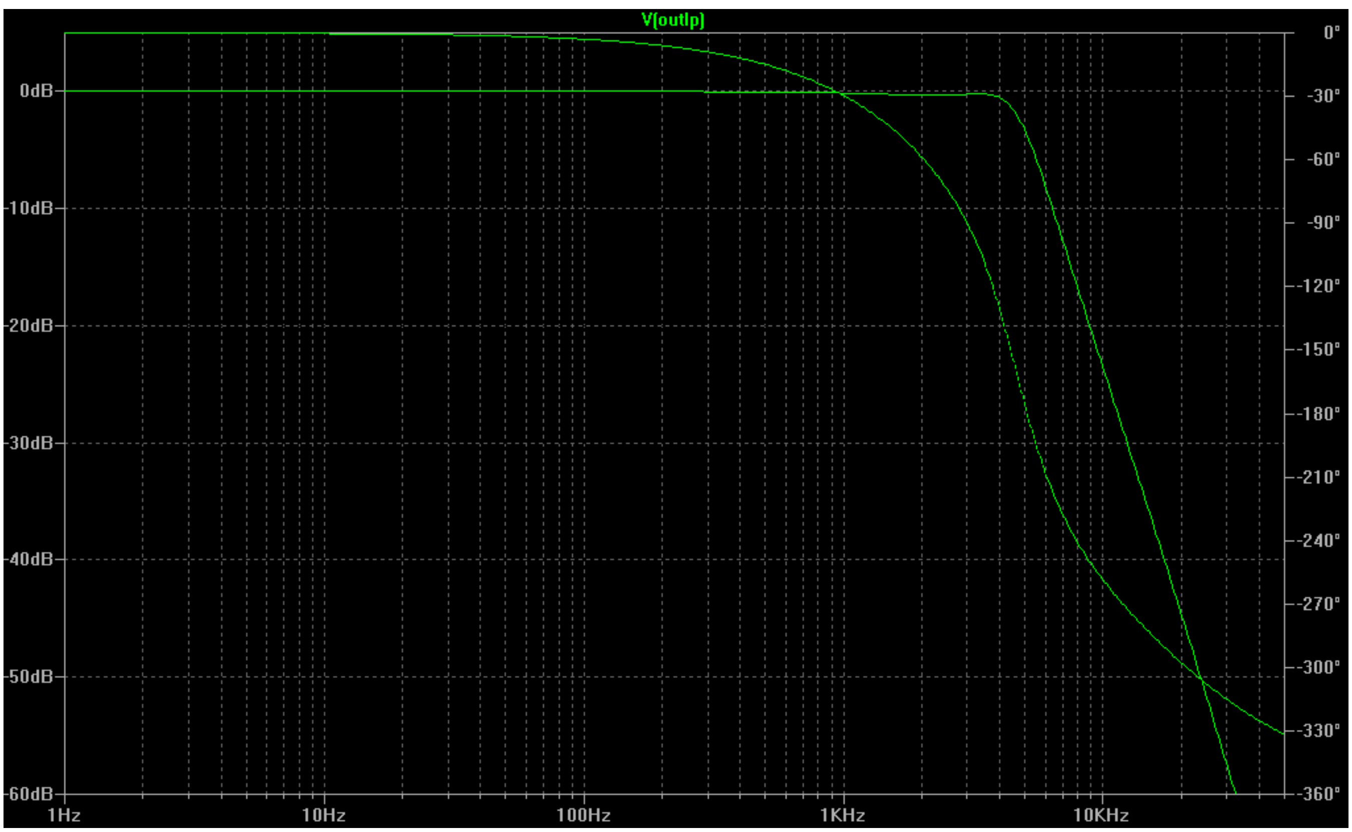


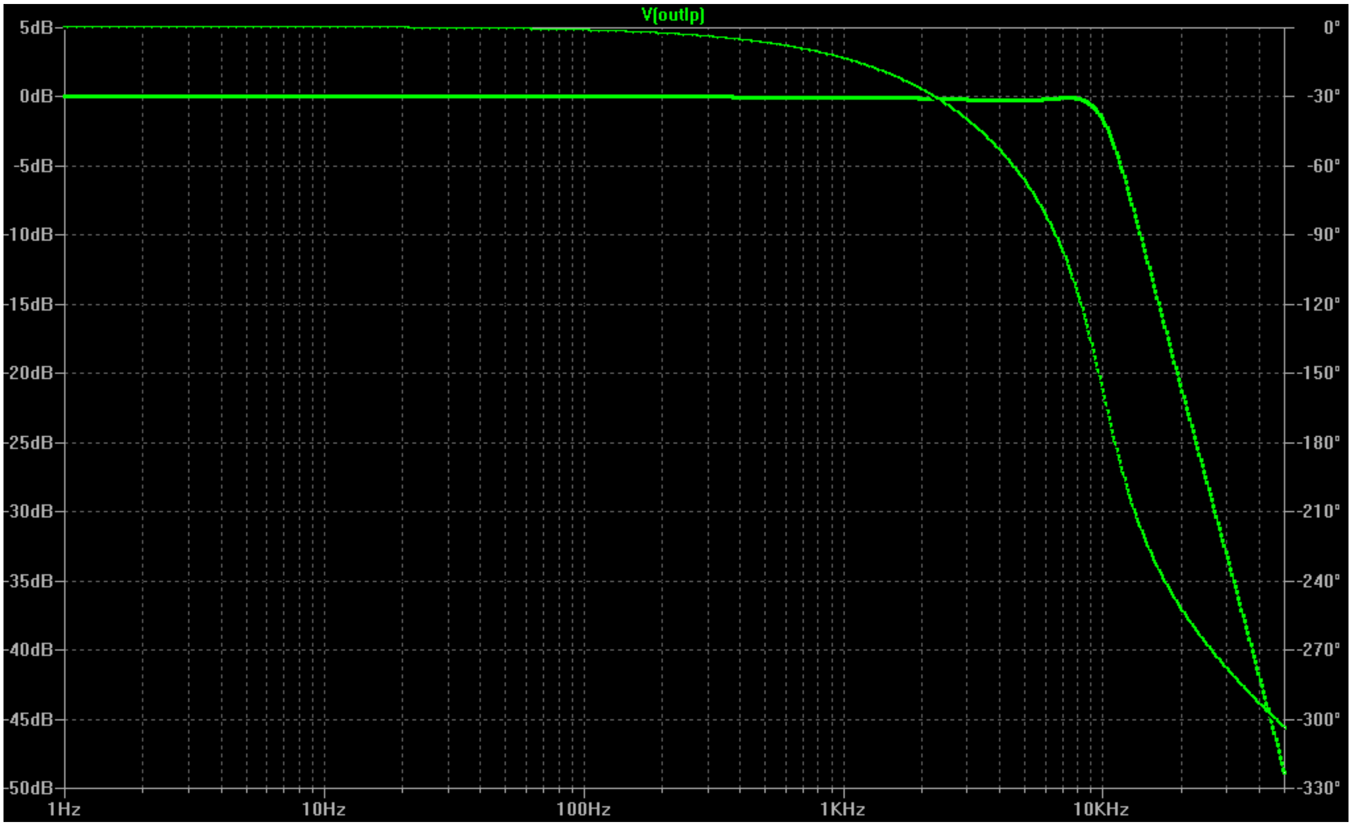
LOW PASS 10 kHz

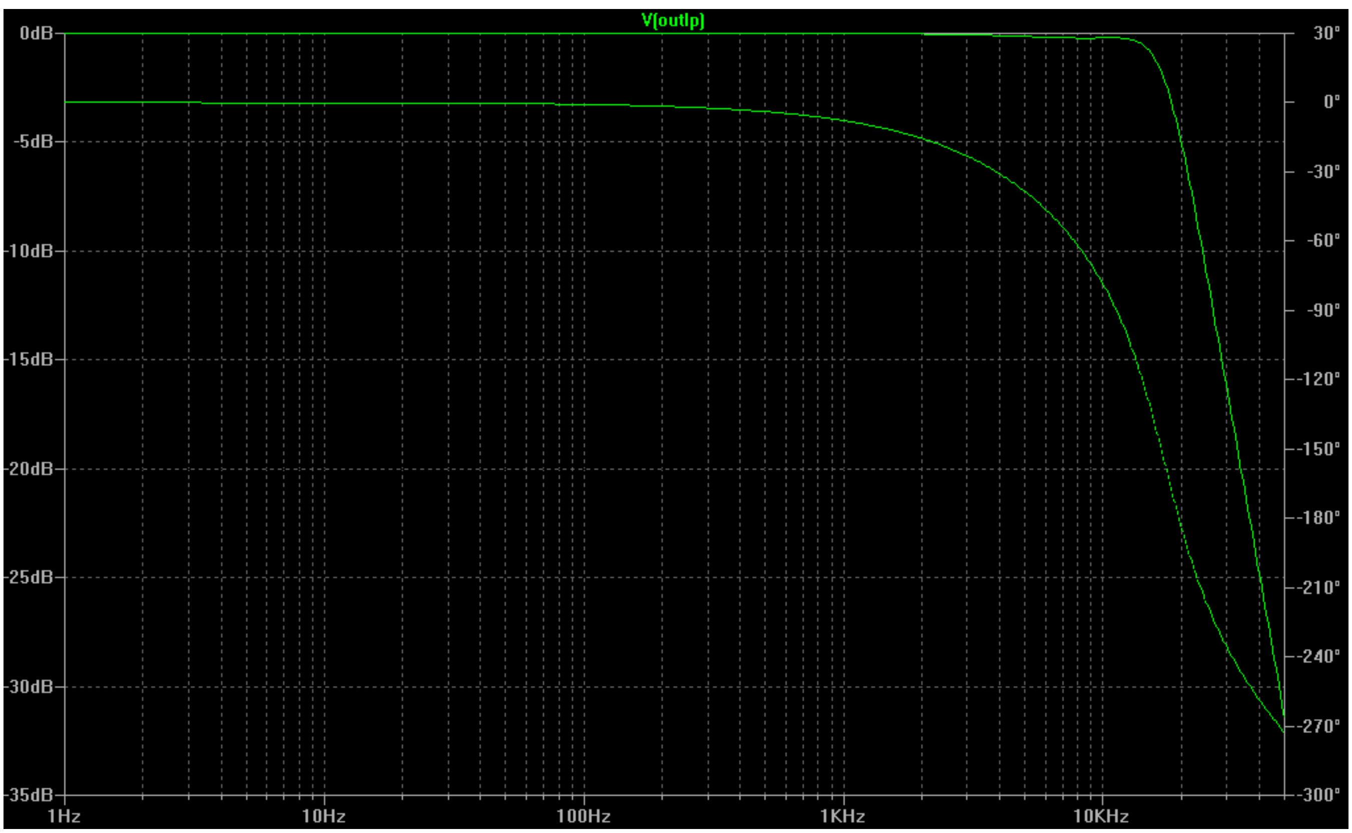


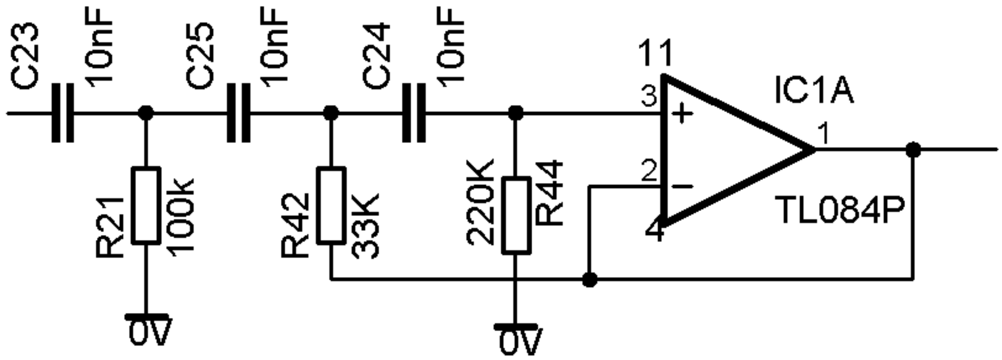
LOW PASS 18 kHz


V(outlp)
10dB
0dB
-10dB
-20dB
-30dB
-40dB
-50dB
-60dB
-70dB
0°
-30°
-60°
-90°
-120°
-150°
-180°
-210°
-240°
-270°
-300°
-330°
-360°
1Hz
10Hz
100Hz
1KHz
10KHz

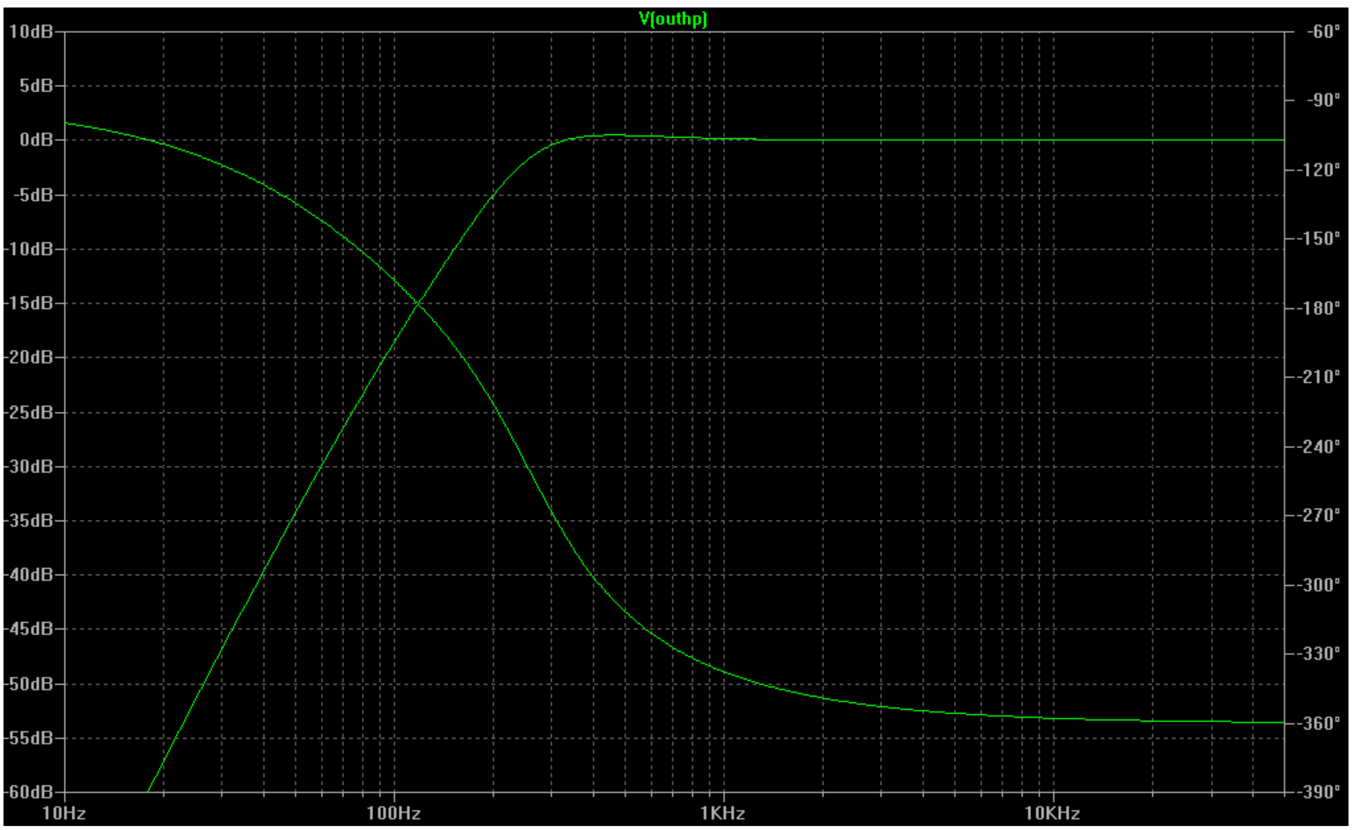

V(outlp)
0dB
-10dB
-20dB
-30dB
-40dB
-50dB
-60dB
0°
-30°
-60°
-90°
-120°
-150°
-180°
-210°
-240°
-270°
-300°
-330°
-360°
1Hz
10Hz
100Hz
1KHz
10KHz


V(outlp)
5dB
0dB
-5dB
-10dB
-15dB
-20dB
-25dB
-30dB
-35dB
-40dB
-45dB
-50dB
0°
-30°
-60°
-90°
-120°
-150°
-180°
-210°
-240°
-270°
-300°
-330°
1Hz
10Hz
100Hz
1KHz
10KHz

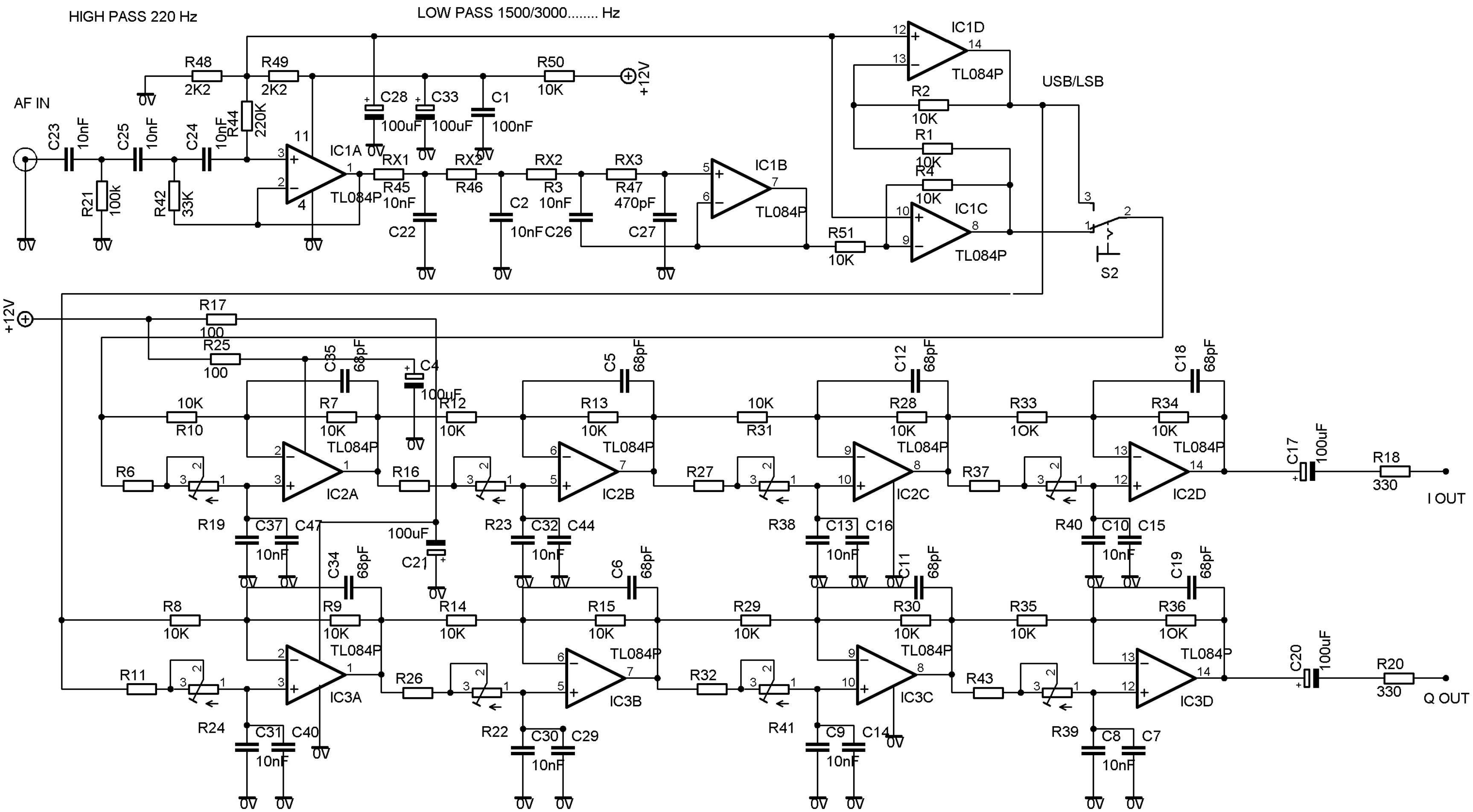

V(outlp)
0dB
-5dB
-10dB
-15dB
-20dB
-25dB
-30dB
-35dB
30°
0°
-30°
-60°
-90°
-120°
-150°
-180°
-210°
-240°
-270°
-300°
1Hz
10Hz
100Hz
1KHz
10KHz



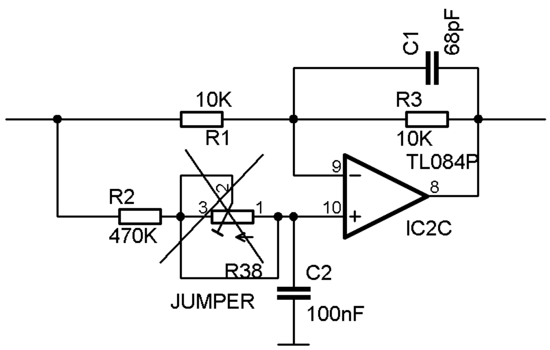
HIGH PASS 220 Hz



At last how schematic for the audio phase shift network 8 order is looking, see drawing down



AUDIO ALL PASS PHASE SHIFTER
YU1LM/QRP



F=1/2 Pi x R2 x C2 = 6 Hz

HOW TO CONNECT UNUSED SECTION FROM OP AMP I CASE AF PHASE SHIFT NETWORKS LOWER ORDER THEN 8

This is my attempt to give new “light” to the old way of obtaining audio quadrature 90 deg I/Q outputs. I wish you successfully realization and I apologize for possible mistakes which I made.

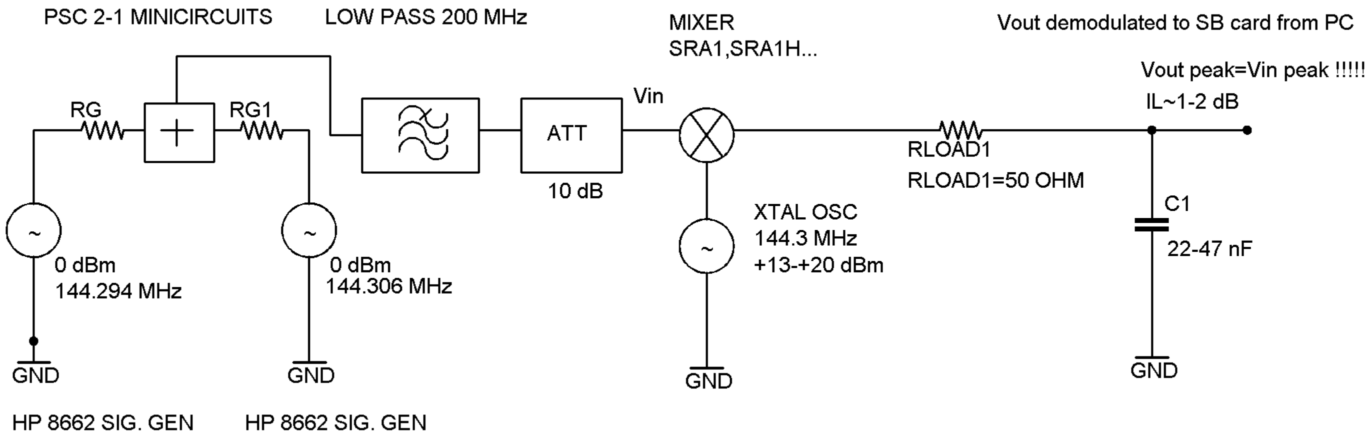
VY 73/72 Tasa YU1LM/QRP
Belgrade July 2006

HF, 6 m, 2 m and 0.7m SDR (Software Defined Radio) Receivers AR1 and AR2 Series -Make it Simple as Possible with Outstanding Performances, part1

Dipl.ing Tasić Siniša-Tasa YU1LM/QRP

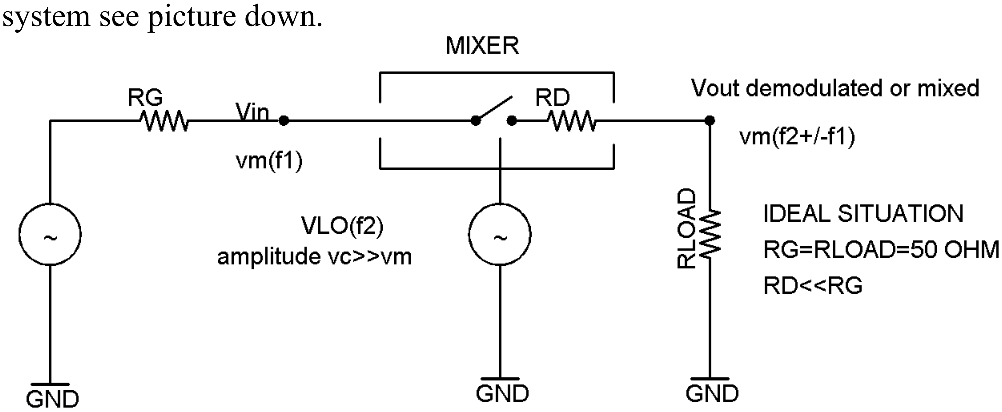
A lot of ham like to try SDR technique at higher VHF and UHF bands 6m ,2 m or 0.7 m. In this moment it is not easy task to make simple SDR receiver for the VHF and UHF HAM bands except if we use some HF SDR receiver (like mine DR1, DR2, DR2….) as first or second IF in classic design with intermediate frequency. I made some experiments in 2004 and tryed to make DC (direct conversion) receiver for high frequencies. I deigned new type of S/H (sample and hold) receiver which is working, even at 23 cm, with very good or better to say fantastic performances with several very cheep components. I will publish this design soon. I was experimenting with an old phasing method for DC receivers before that. I revised it and here are some mine results of my try to enable new bands for SDR at simple and easy way. These designs are in connections with results of mine DC designs for professional use.

First receiver is AR1 which is simple as possible with only one branch without image rejection. It is a design similar to mine previously published receivers DR1 and DR1A. VHF and UHF HAM bands which hare very small portion of the central frequency and because of that they are ideal for the phasing method in receiver design. AR2 receiver is receiver with image rejection and design is similar to a lot of mine designs staring from the DR2, DR2A….. The phase shifting is happening at LO (local oscillator) branch at the receiving frequency. Both receivers are without RF pre-amplification, it isn't to big disadvantage as I expected. Receivers still have a very good sensitivity even without RF amplification. Also receivers are without LO. I will make some proposal in part 2 but every builder can decide how to make LO for the receivers fixed or variable LO. It isn't possible design oscillator which will work at 50 MHz and 432 MHz at the same time. Lets start from the some theoretical facts without too much mathematics. Resistive broadband termination is very important for diode mixer especially IF port in mixing process. A lot of articles have been written with this subject and it is key for achieving max IMD performances from used mixer. It is very hard to obtain IMD2 and IMD3 numbers declared from manufacturers in practically realized circuits. But for the demodulation we have similar situation with one little relaxing thing that we can very easy achieving RF termination. I didn't make power termination at demodulator port for demodulated signal as I do leading all relevant articles. I made only voltage match. My test gave results which are very interesting and I didn't find similar realization in other designs. Down is a picture how I measured demodulator IMD3 performances with SB card. I obtain at PC screen IP3 from 24-26 dBm for SRA1H mixer MiniCircuits what is very good results for unmatched port not so far from max IP3 30-32 which had been declared from manufacturer.

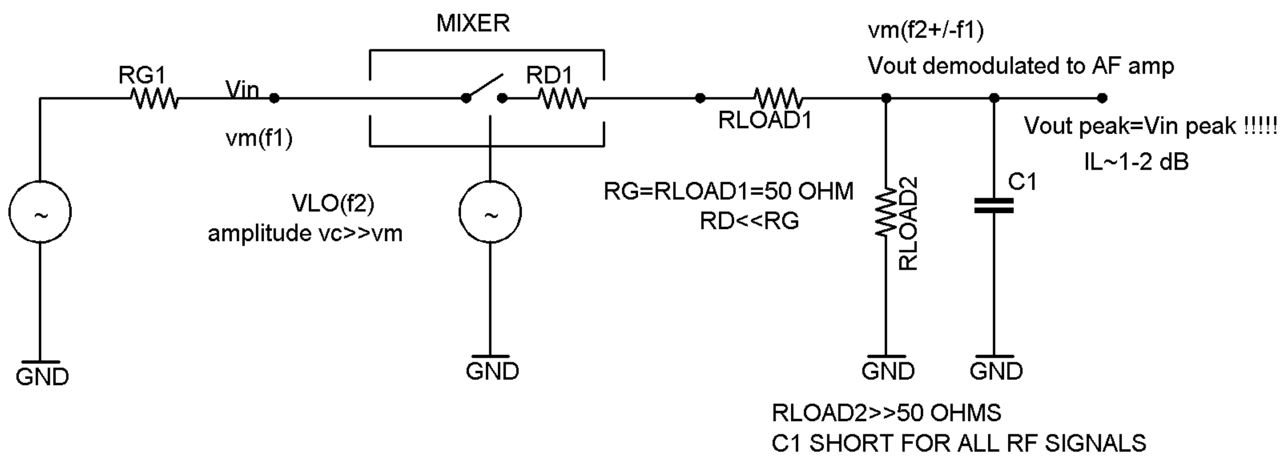


DEMODULATOR USED IN HF/VHF/UHF SDR RECEIVERS AR....SERIAS YU1LM IMD3 MEASUREMENTS

If we simplified receiver with passive detector min IL (insertion loss) is 3 dB in terminate system see picture down.



MIXER EXTREMELY SIMPLIFIED



DEMODULATOR USED IN HF/VHF/UHF SDR RECEIVERS AR....SERIAS YU1LM EXTREMELY SIMPLIFIED

The mixer and diode as mixing elements are presented as resistor, half energy go to receiver in ideal terminate system. In double balanced mixer we have two branches and we have common connection in which one IF port is grounded that mean half of useful energy goes to the ground this lead to additional losses which are common for the most double balanced mixers 4-6 dB. One way to overcome this situation, which was not used often in past in published and realized designs for diodes mixer, it is using balanced post mixer amplifiers. This means that we also must have a termination at both input ports very important to obtain good dynamic performances IP3, DR...from used diode mixers. I designed low noise balanced

AF amplifiers with bipolar transistors and JFET few times in past. Now to simplify realization I am using ultra low noise OP AMP (better OP AMP like "state of the art" Analog Device AD797 or LT1115 from Linear Technology), it is much easy to achieve better results in overall NF (noise figure)), instead pre amplifier with bipolar transistors (it is possible better NF in some schematics even 0.3- 0.4 nV/SQR (Hz) or NF 0.5 dB). Using some easy obtainable low noise OP Amps like OP027, NE5534… will ruin overall receiver NF for few dB, 3-10 dB. This OP AMP specification is spoiling NF and results is related with chosen type OP AMP connection and chosen component values. At picture down show how OP AMP can be analyzed in noise calculation for case inverting OP AMP and non inverting connections and how these performances are for cases 2 most used low noise OP AMP AD797 and cheaper NE5532 used in most mine design for HF bands. The data had been taken from data sheets from Analog Devices and Philips OP AMP manufacturers.

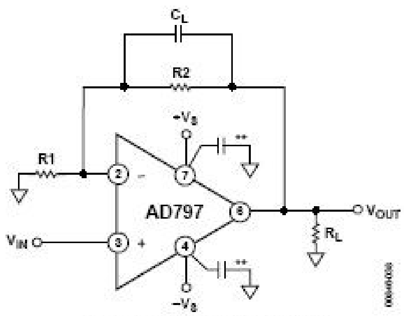


Figure 38. Low Noise Preamplifier
***Use Power Supply Bypassing Shown in Figure 35*

Table 4. Values for Follower with Gain Circuit

Gain	R1	R2	C_L	Noise (Excluding rs)
2	1 kΩ	1 kΩ	≈20 pF	3.0 nV/√Hz
2	300 Ω	300 Ω	≈10 pF	1.8 nV/√Hz
10	33.2 Ω	300 Ω	≈5 pF	1.2 nV/√Hz
20	16.5 Ω	316 Ω		1.0 nV/√Hz
>35	10 Ω	(G − 1) × 10 Ω		0.98 nV/√Hz

The I-to-V converter is a special case of the follower configuration. When the AD797 is used in an I-to-V converter, for example as a DAC buffer, the circuit of Figure 39 should be used. The value of C_L depends on the DAC and again, if C_L is greater than 33 pF, a 100 Ω series resistor is required. A bypassed balancing resistor (R_S and C_S) can be included to minimize dc errors.

THE INVERTING CONFIGURATION

The inverting configuration (Figure 40) presents a low input impedance, R1, to the source. For this reason, the goals of both low noise and input buffering are at odds with one another. Nonetheless, the excellent dynamics of the AD797 makes it the preferred choice in many inverting applications, and with careful selection of feedback resistors, the noise penalties are minimal. Some examples are presented in Table 4 and Figure 40.

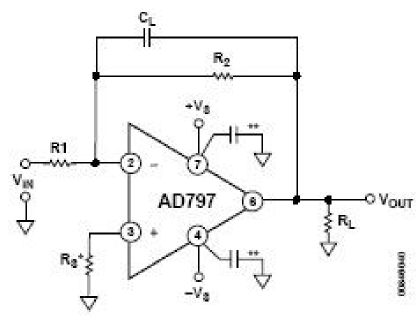


Figure 40. Inverting Amplifier Connection
***Use Power Supply Bypassing Shown in Figure 35*

Table 5. Values for Inverting Circuit

Gain	R1	R2	C_L	Noise (Excluding rs)
−1	1 kΩ	1 kΩ	≈20 pF	3.0 nV/√Hz
−1	300 Ω	300 Ω	≈10 pF	1.8 nV/√Hz
−10	150 Ω	1500 Ω	≈5 pF	1.8 nV/√Hz

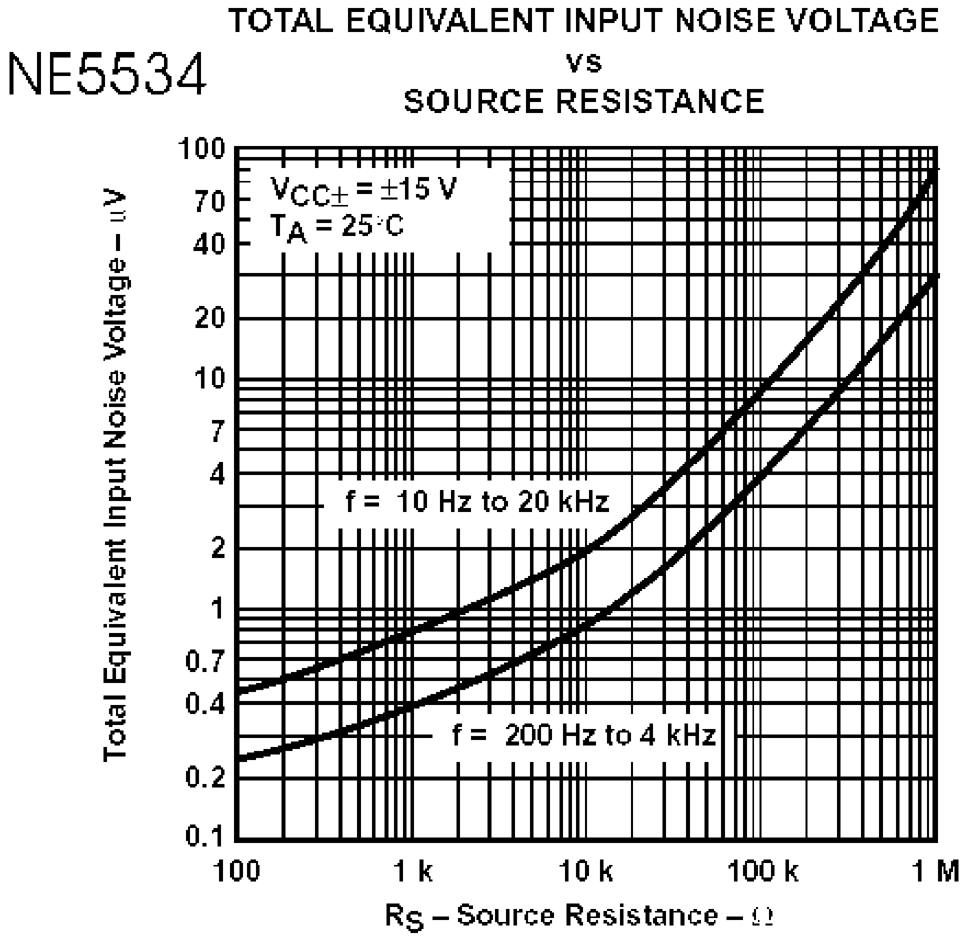


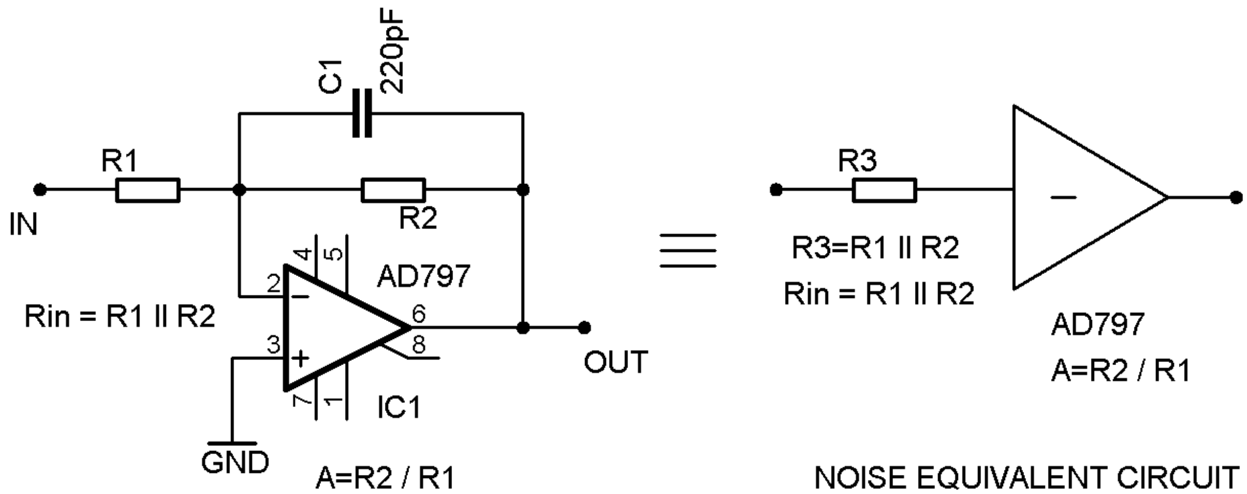
Figure 9

If we are looking in these diagrams most readers will not understand what they and what numbers mean exactly, except that noise numbers have to be smaller as possible. Let we start with very simple mathematics and ordinary case with resistor as noise source as help in better noise problem understanding.

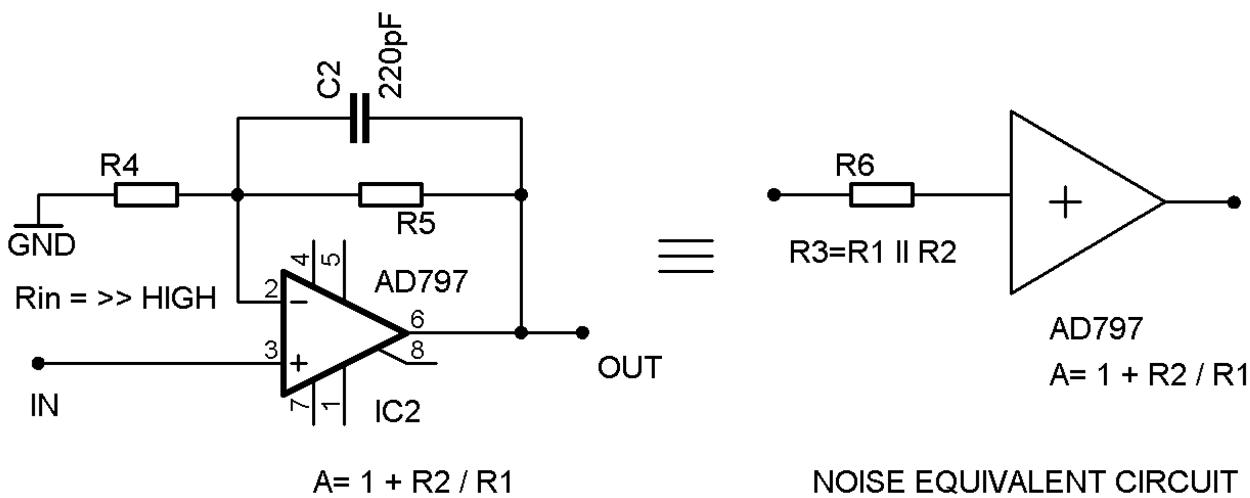
En= SQRT(4kTRB) …………………………(1)

En=RMS noise voltage in [V]
K= Boltzmann constant 1.38 10 EXP-23 [J/K]
T =room temperature in [K]
R= resistance [Ohms]
B=is the noise bandwidth [Hz]

For the 50 Ohms resistor we are obtaining that it is En=140 nV for B= 24 kHz. Why B=24 kHz because it can easily be measured with audio programs. The bandwidth reduction for listening will increase MDS but this parameter depend from many things SB card quality setting in signal processing OP AMP performances and used configuration. We can also substitute OP with resistor and equivalent resistor noise source and ideal noiseless OP AMP. Very low voltage loss in mixer enables me to make SDR receiver with very good sensitivity even without RF pre amplification.



INVERTING OP AMP CIRCUIT

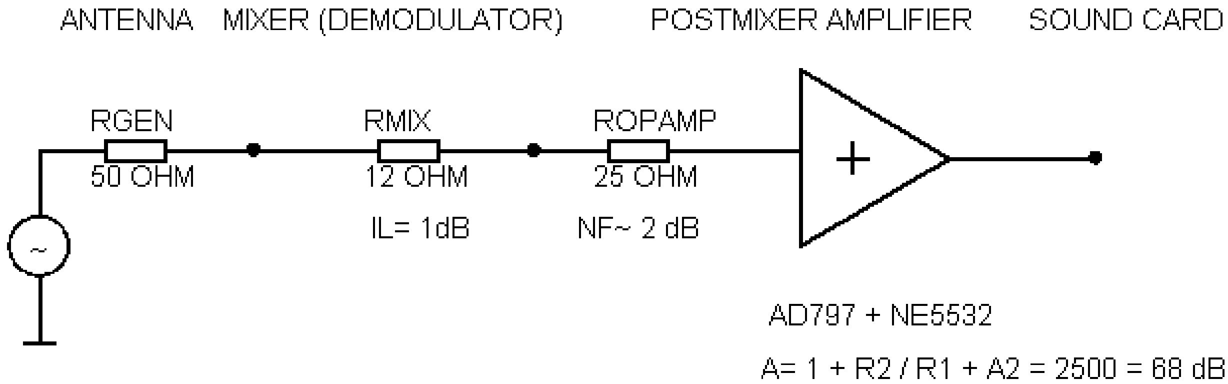


NONINVERTING OP AMP CIRCUIT

If we assume that OP AMP for example in non inverting configuration has equivalent noise from En = 1 nV / SQR (Hz) we can calculate (from formula 1) that AD797 we can replace with 25 Ohm resistor and ideal noiseless amplifier. Also we can add one 12 Ohms resistor for mixer losses in this configuration and than we can calculate equivalent noise at input noiseless amplifier. The equivalent noise is at input of ideal lossless amplifier we will calculate according formula (2) 25 Ohms from mixer and OP AMP will give equivalent noise of 140 nV according to formula (1).

Eeq = SQRT((EnxEn + EdiodexEdiode+ E opamp x Eopamp)) ………….(2)

Eeq= SQRT((140 nVx140 nV + 121 nV x121 nV))= 185 nV



The maximum gain in receiver is 68 dB or 2500 times this will give 2500 x 185 nV= 0.46 mV noise for +/- 24 kHz bandwidth at the output of receiver. If we read carefully articles from Gerald AC5OG part 4 ,we can read that even sound card best quality have limitation in capability to receive max signal of 10-12 V peak-peak at input. The maximum number of possible useful bits from sound card is not determined with SB quantization levels. It is not possible to achieve max number of bits, we are loosing LSB bits always. The producer had been announced in 24 bit SB card specification max S/N of 102 dB. This data mean that instead 24 x 6.02 +1.75 = 146.23 dB we have to lost 7 LSB bit and that we have 16.7 equivalent bit resolution for signal processing. According to Gerald AC5OG article's calculations we can determine minimum quantum level at level -75 dBm (for 24 bit SB Audigy NX2). From this data we can determine also noise figure NF for SB card in B=24000 Hz.

NF sound card [dB] =quantum level -174 dBm-10 log B [Hz] = 55 dB

From other side system noise is

-174 + 10 log (B [Hz]) [dBm] =0.45 nV/SQRT (Hz)

Or for bandwidth B=24000 Hz receiving system has noise at input
-130 dBm= 70 nV

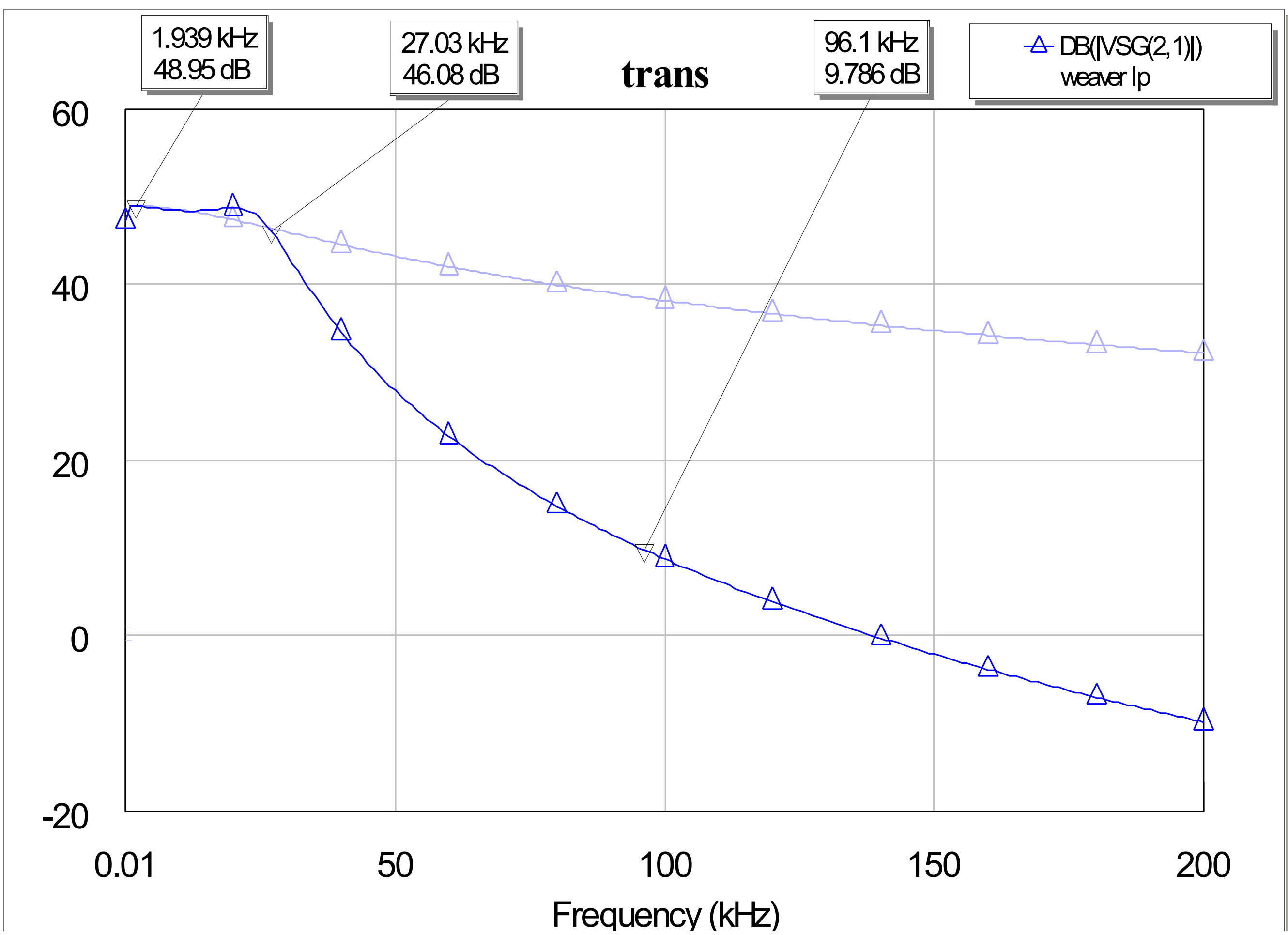
From the other side MDS for SB used card is – 174 dBm – 55 = -119 dBm referenced to the input port. For the 2 meters band terrestrial noise is 2 dB in quite environment.
Signal from 0.46 mV referenced to input and with gain from 68 dB is giving receiver MDS = -54 dBm - 68 dB = -122 dBm or RX NF from -122 + 130 = 8 dB This values will seem to all readers high too much but for normal bandwidth 500 Hz equivalent natural noise is :

- 174 + 10 log (500Hz) = - 147 dbm or with NF =8 dB or MDS (S/N=3 dB) is - 136 dBm or 36 nV. Practically results are next, I can easy hear in head phones at receiver output signal from 80-100 nV or -129 -127 dBm at input. For the increasing receiver sensitivity to -138-141 dBm I am using preamplifier with Agilent HP GaAs transistor ATF 54143 NF broad band circuits amplifier mine design from 50 -430 MHz measured NF was better than 0.7 dB including input circuits . The final result was NF for whole 2m receiving system was better than 1 dB. The result is determined with many parameters starting from used hardware and SB quality also with setting inside SDR programs. I have admit also that for receiver without image rejection we have problem with DSB noise and because of that we have some deviation from exactly calculated number but this deviation is in range of 2dB maximum (theoretically max influence is 3 dB for receiver wit very bad NF). The receiver NF is good enough for all terrestrial communication and even for satellite communication. I didn't try this system to real 2 m signals because I am orthodox HF HAM and I measured all results with instruments and signal generators as signal sources.

Now I will leave theoretical consideration and explain how to make receivers series:

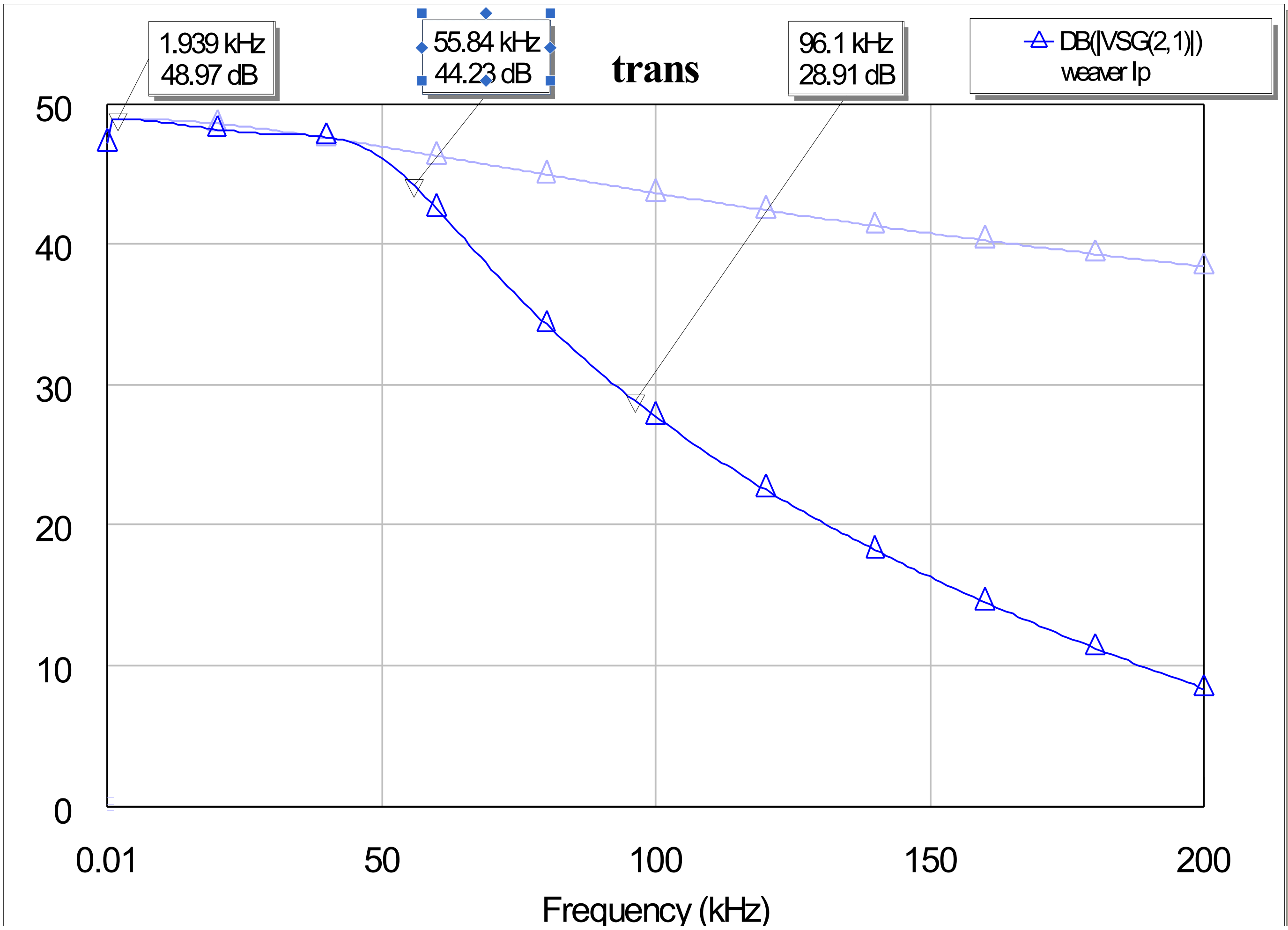
1. AR1 (simple as possible) HF/VHF/UHF SDR receiver without image rejection with encapsulated mixer such as SRA1, SRA1H, and HPF505….**2.** The **AR1-1** RX is the same RX as AR1 but with homebrew mixer. I gave one possible solution for AR1-1 without any ferrite for frequencies from 50-250 MHz,
3. AR1B HF/VHF/UHF SDR receiver without image rejection with encapsulated mixer such as SRA1, SRA1H, HPF505,… (Please take care that are all diode ports free not connected to can like in SBL…series). AR1B receiver has balanced instrumental audio amplifier realized with ultra low noise OP AMP AD797 or LT1115.
4. AR1C is the same RX as AR1B receiver but with ordinary low noise OP AMP such as NE5532…… This realization has the worst NF from all proposed RXs here.

All receivers can be realized in 2 versions with additional LC low pass filter or without it. Choice is on the RX builder side. RC low pass filter is the same as I am using in mine HF SDR RX designs and at diagrams we can see difference. I have to notice also that this RC low pass frequency amplitude characteristic is selectivity around sampling frequency, selectivity without LC components. It is quite natural that amplitude frequency response is not flat without additional LC filter.

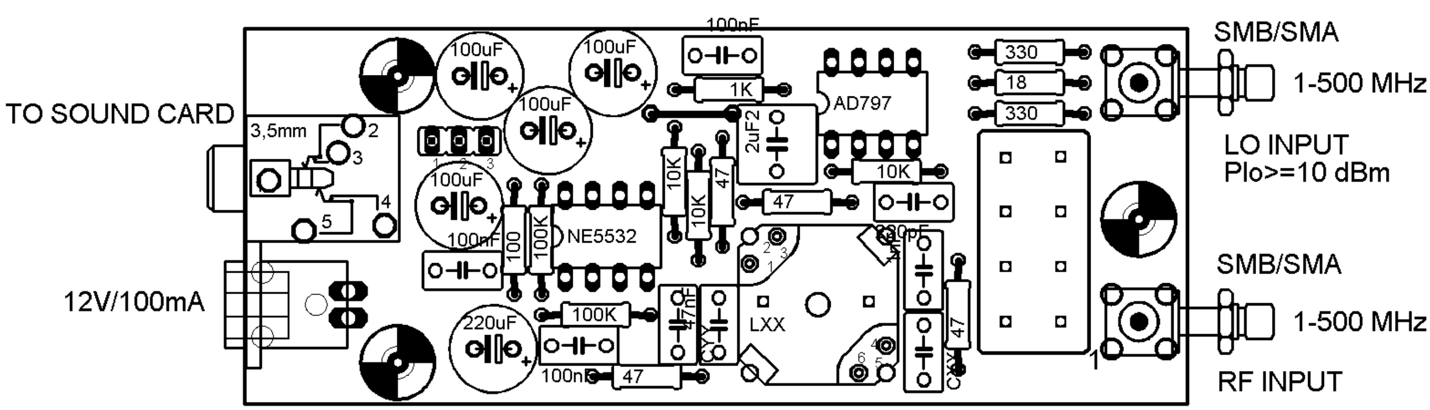


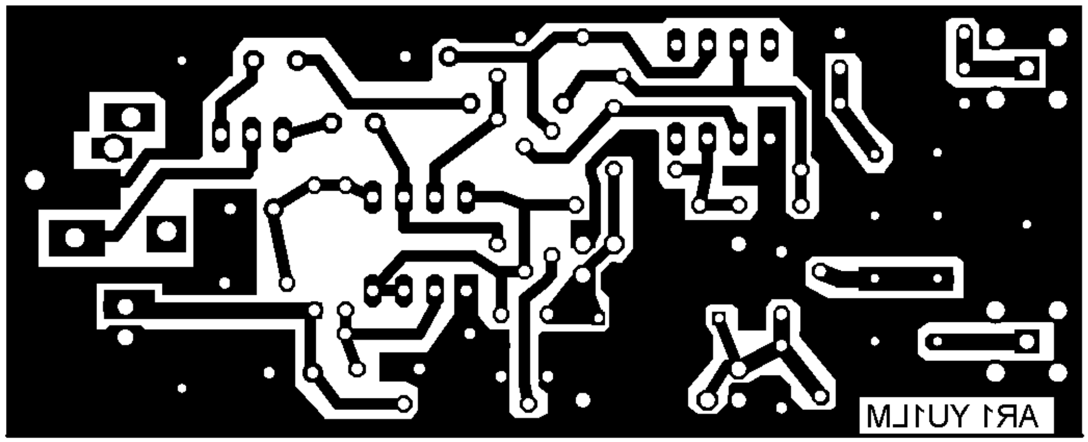
CXX=47 nF (faded line) or with RLC filter CXX=47 nF, LXX=1 mH, CYY = 82 nF

Version 2 if we increase bandwidth new elements are now for RC version CXX=22 NF (faded line) and RLC version is CXX= 22 nF, LXX = 470 nF, CYY = 47 nF

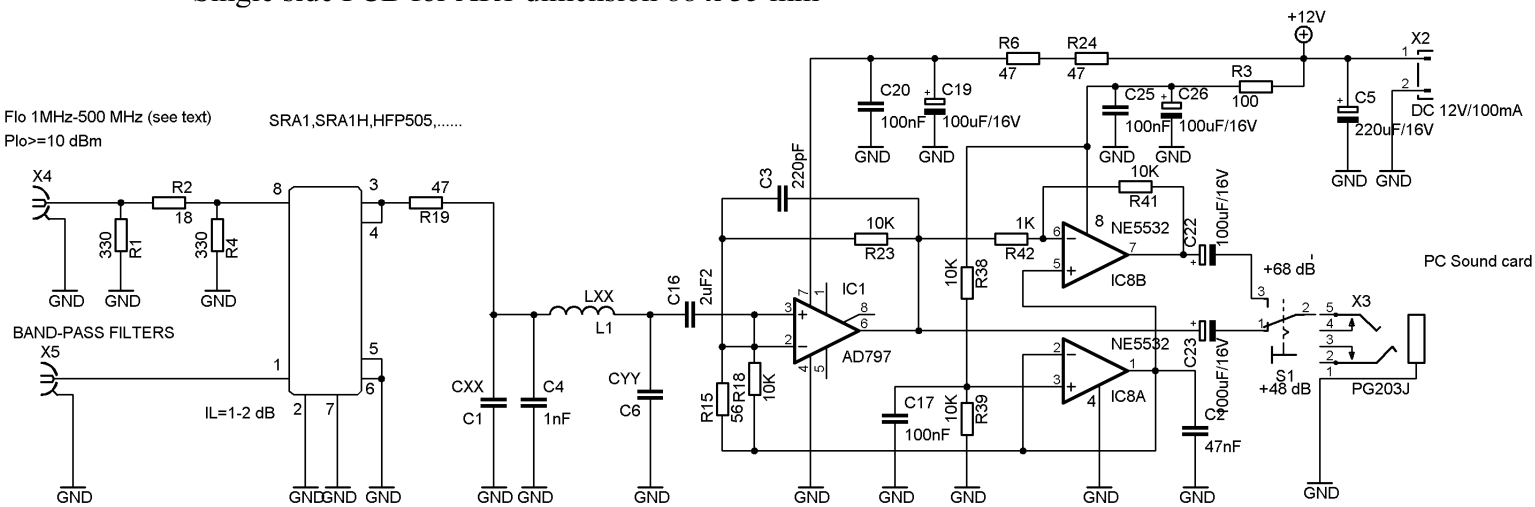


1. AR1 and AR1-1 SDR receivers in version without LXX it had been replaced with jumper and CYY was omitted.



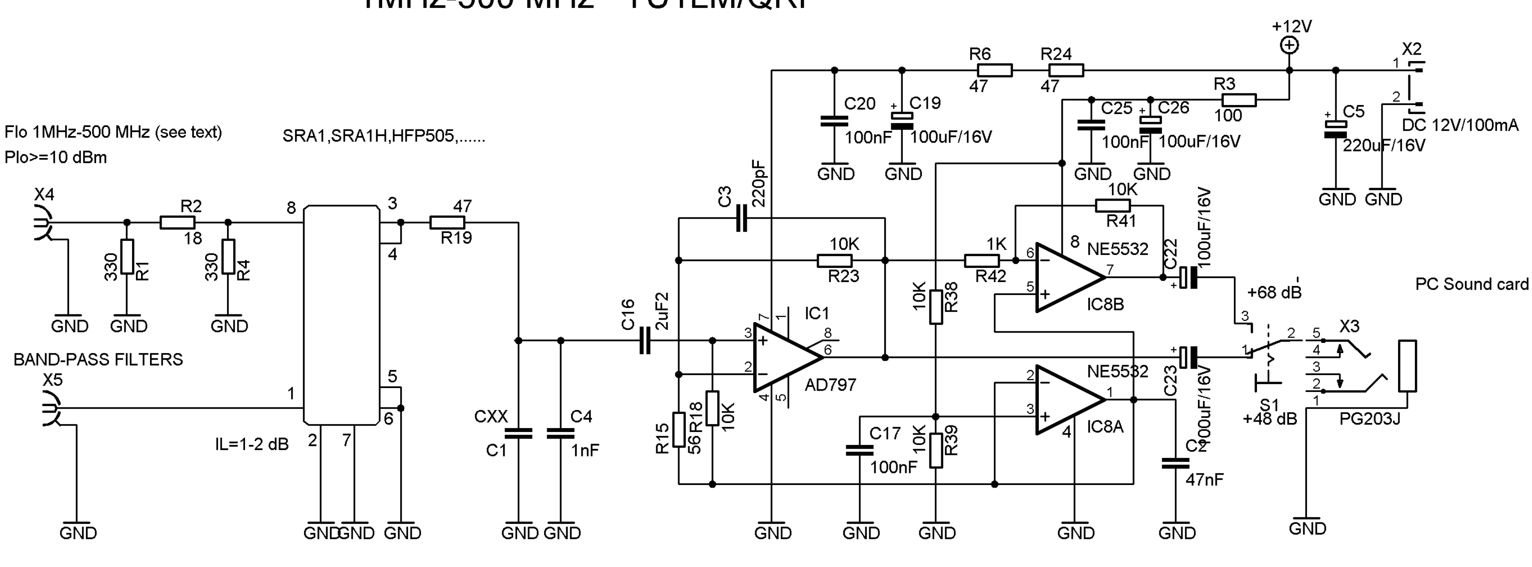


Single side PCB for AR1 dimension 88 x 35 mm



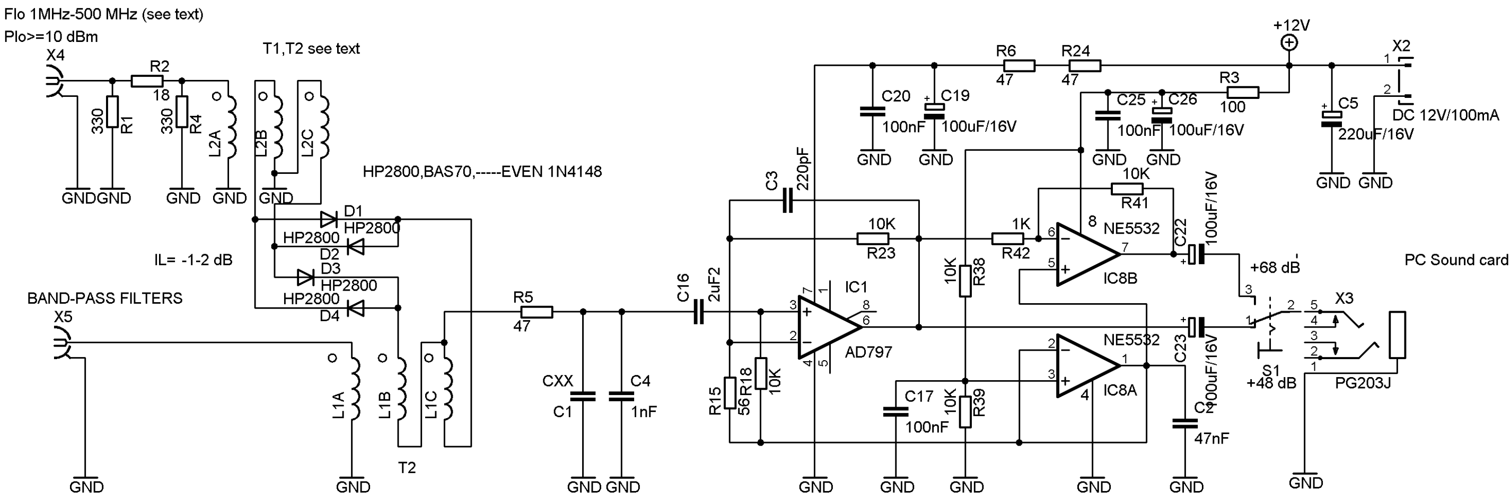
HF/VHF/UHF SDR Receiver AR1

1MHz-500 MHz YU1LM/QRP



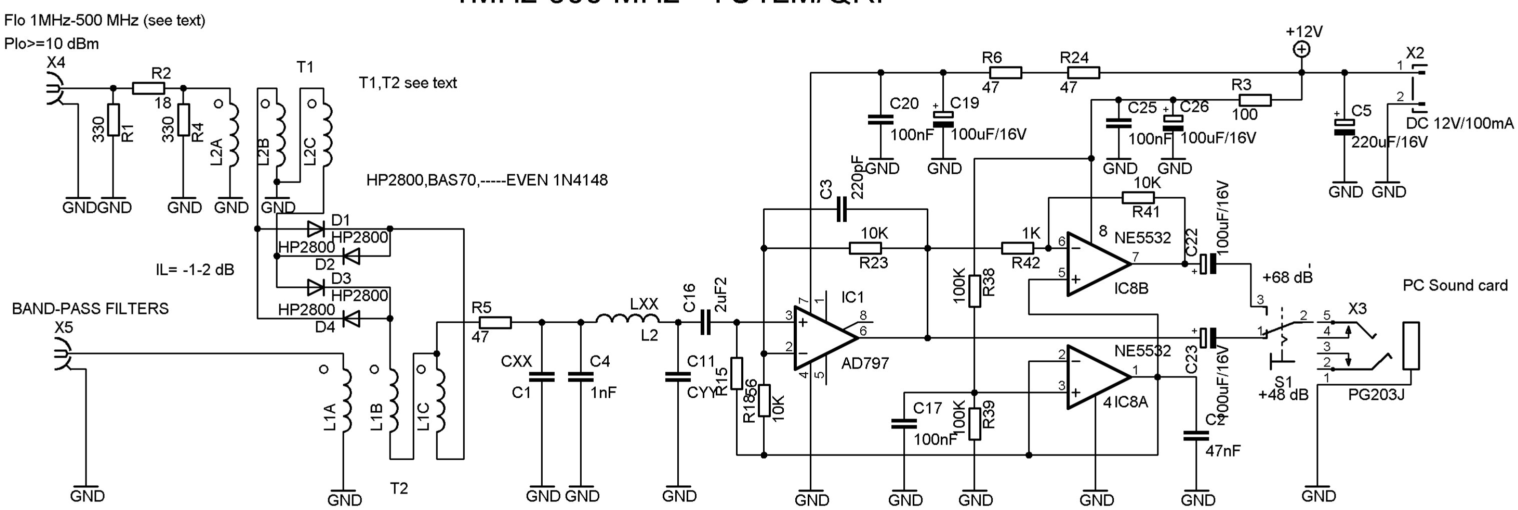
HF/VHF/UHF SDR Receiver AR1

1MHz-500 MHz YU1LM/QRP



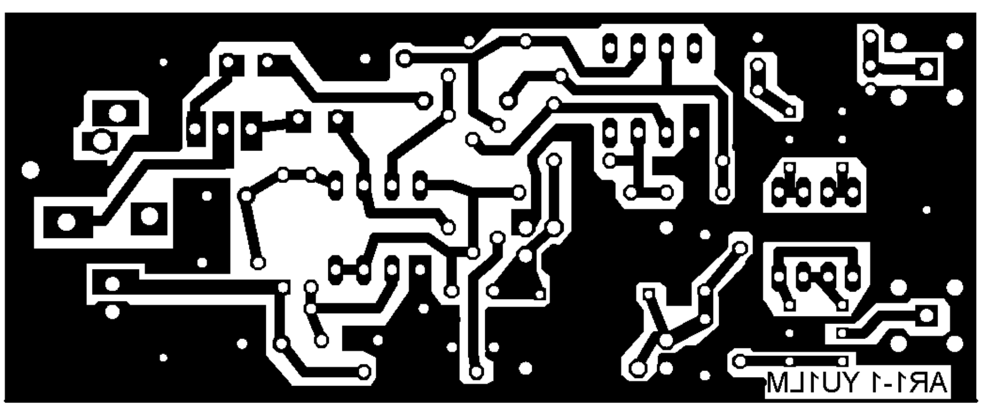
HF/VHF/UHF SDR Receiver AR1-1

1MHz-500 MHz   YU1LM/QRP

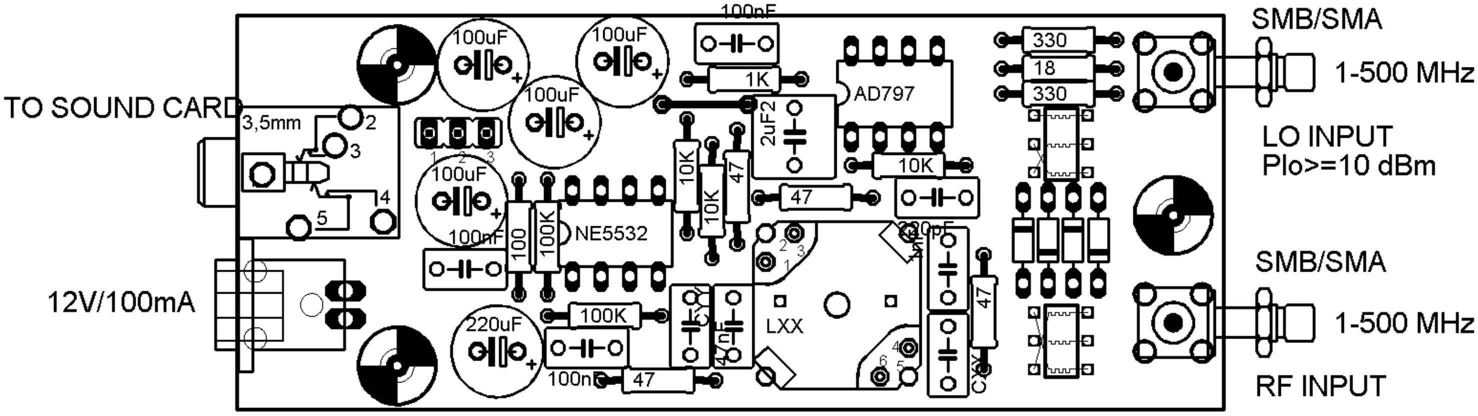


HF/VHF/UHF SDR Receiver AR1-1

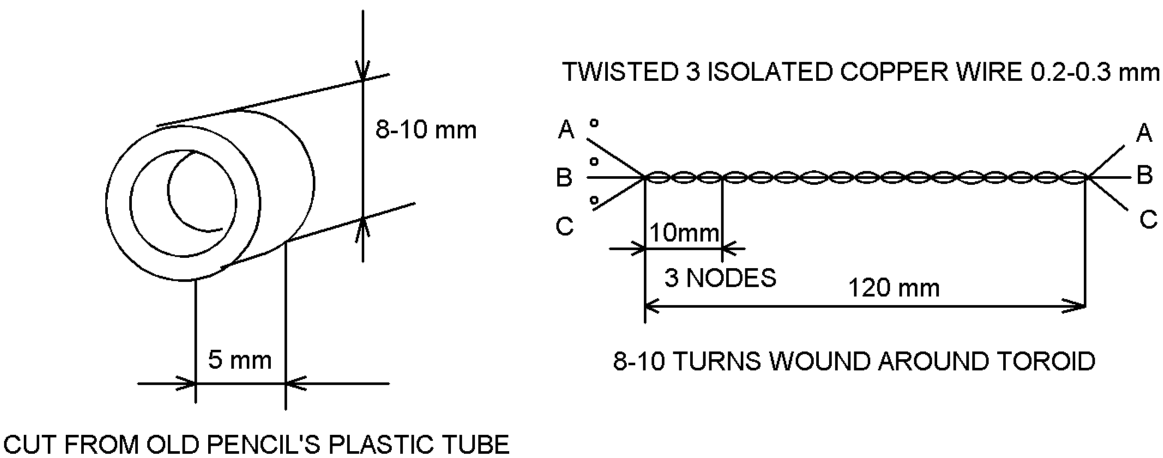
50MHz-500 MHz   YU1LM/QRP



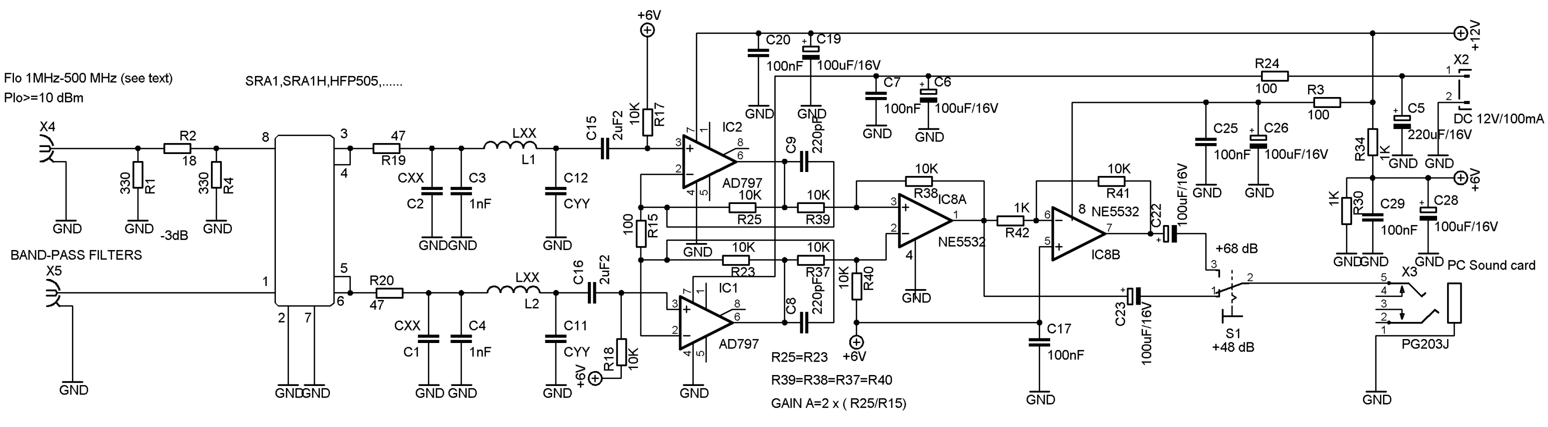
Single side PCB for AR1-1 dimension 88 x 35 mm



It is possible to make transformers T1, T2 for AR1-! without any ferrite see down how I do this. Of course it is possible use ferrite and than wound adequate numbers turns but it is very important ferrite quality if we want to achieve broadband characteristics. These PVC plastic toroids are working very well between 50-250 MHz. For lower frequencies it is necessary to increase turns number for higher it is necessary to decrease turns number. Increasing turn number will decrease bandwidth from upper side or vice versa.

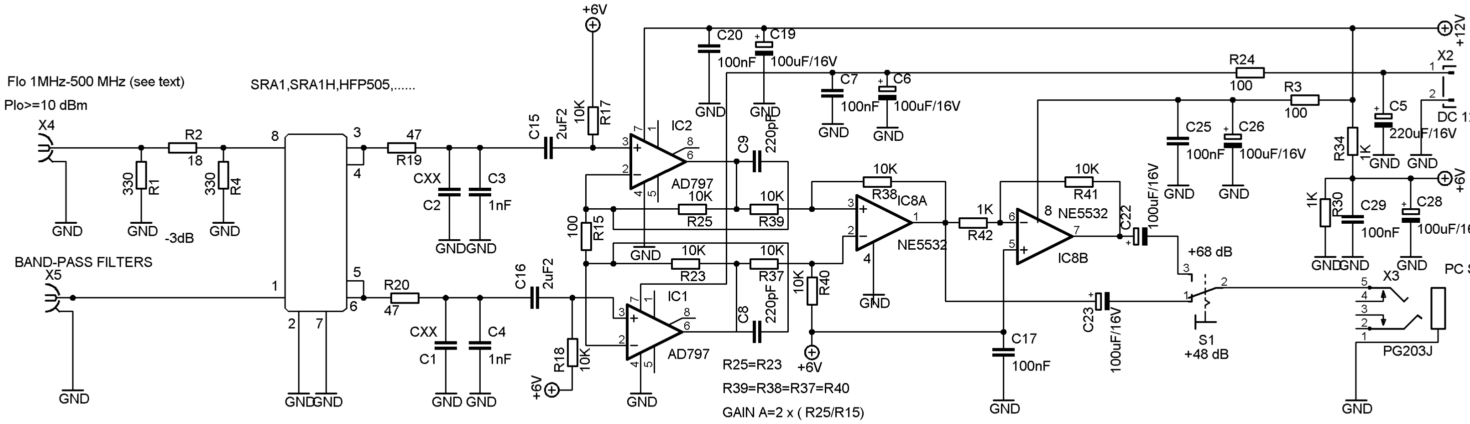


HOW TO MAKE PLASTIC T1,T2 TOROID TRANSFORMERS FOR AR1 AND AR1-1 FREQUENCY RANGE 50-250 MHz



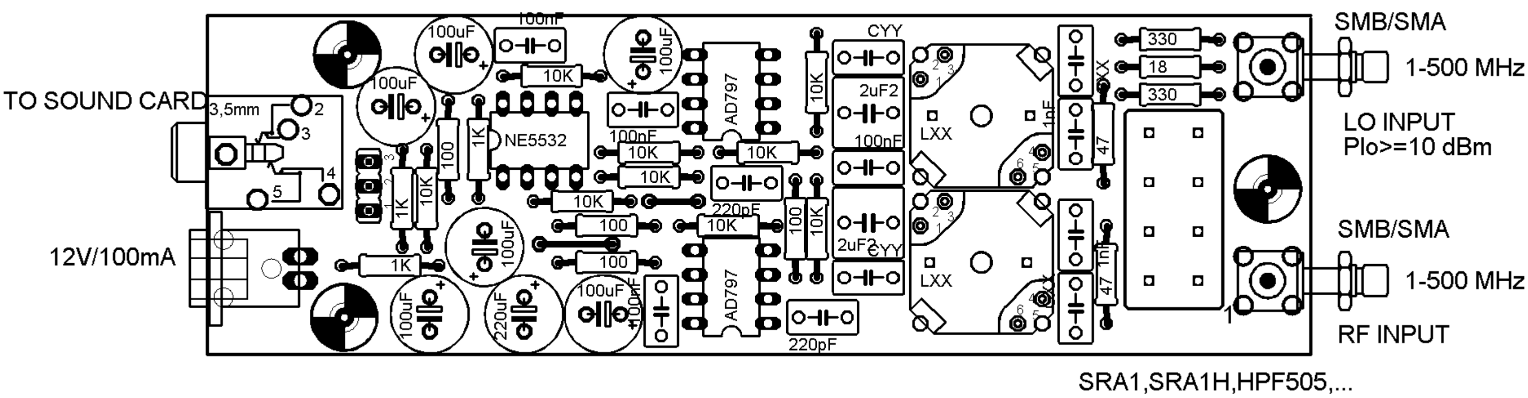
HF/VHF/UHF SDR Receiver AR1B

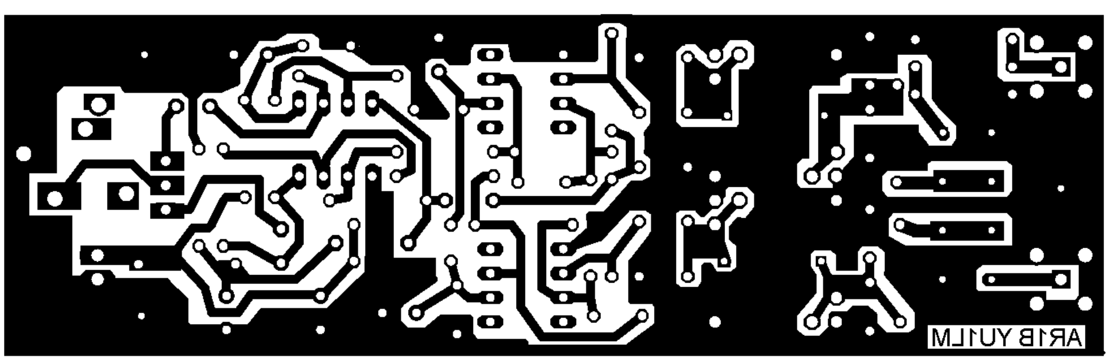
1MHz-500 MHz YU1LM/QRP



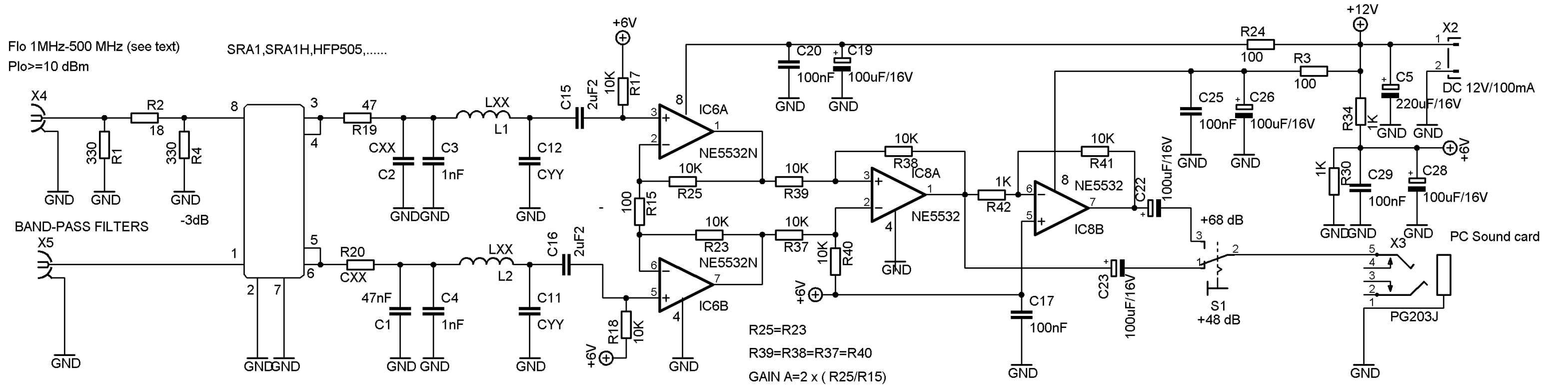
HF/VHF/UHF SDR Receiver AR1B-1

1MHz-500 MHz YU1LM/QRP



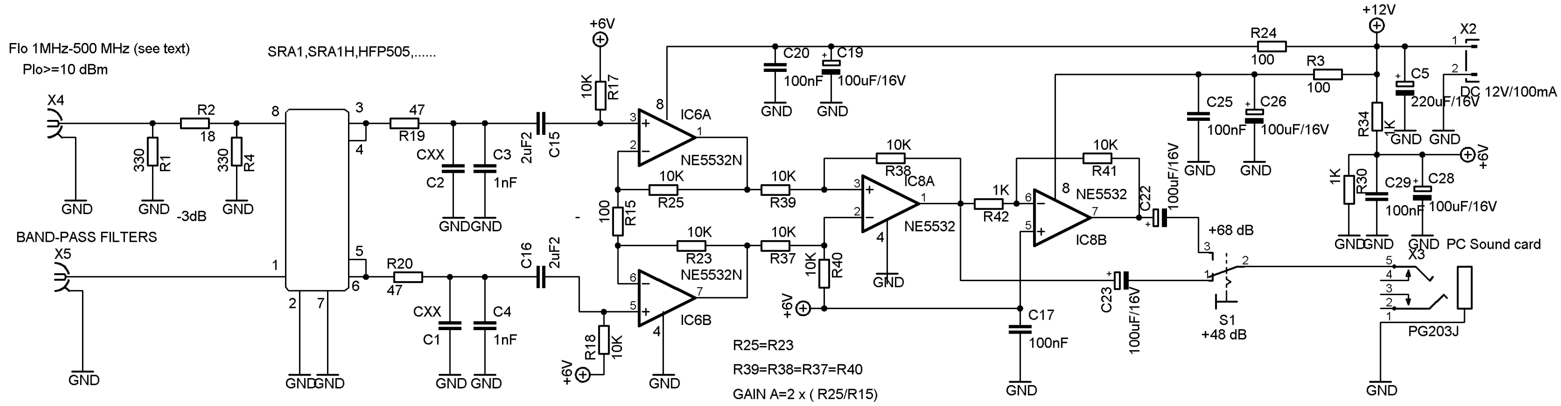


DR1B SDR receiver, single side PCB dimensions 115 x 36 mm



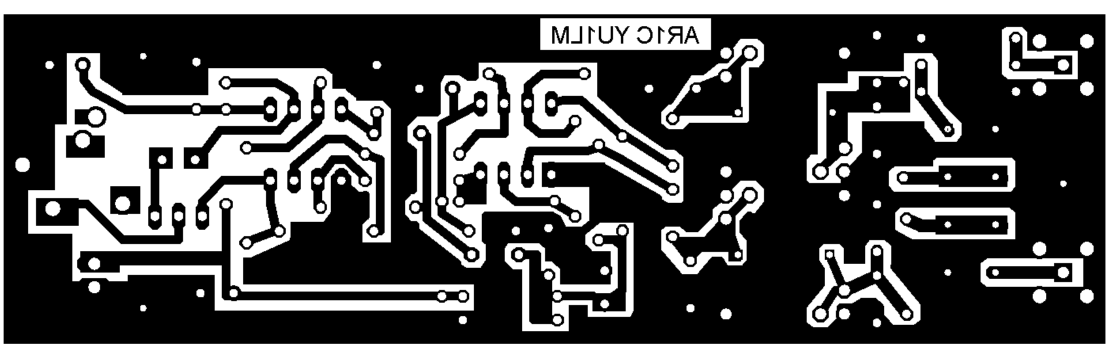
HF/VHF/UHF SDR Receiver AR1C

1MHz-500 MHz YU1LM/QRP

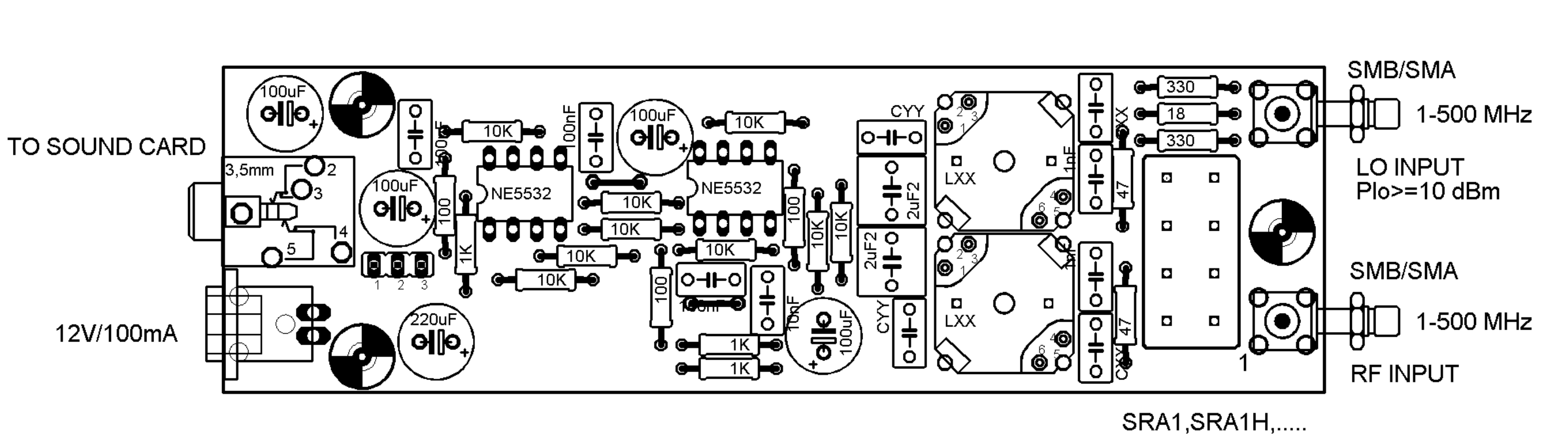


HF/VHF/UHF SDR Receiver AR1C-1

1MHz-500 MHz YU1LM/QRP



AR1C SDR receiver, single side PCB dimensions 118 x 36 mm



There is no adjustment for these AR1…receivers and all have to work instantly. There are some other performances for all receivers with SRA1H like:

1. 1dB compression point is at input level -25 dBm or 59 +78 dB!!!! (all receivers without RF pre amplification)
2. IIP3 is -10 dBm for SRA1H

In part I will describe AR2 series it is combination AR1.. sreies and Wilkinson power splitter at RF input and quadrature splitter at LO input between 2 RX. I will also describe some possible LO for RX. We can divide LO at possible 4 solutions:

1. Fixed XTAL oscillator (5,7th overtone)(separate article –Universal HF/VHF oscillator)
2. Very good DDS LO with AD9951
3. Mixed circuit between DDS LO with AD 9850(51) and REF oscillator for DDS 120 -125 MHz
4. PLL LO

I wish you successful AR1….RX realization and I am apologizing for the some possible mistakes. I made great effort to make SDR projects and share them with all who are interesting for. Send me your comments positive or negative anyway, results or photos of your realization please.

GL in SDR homebrew and VY 73/72 Tasa YU1LM/QRP

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stasic@eunet.yu

References:

1. ***www.qsl.net/yu1lm/homebrew***
2. ***www.yu1lm.qrpradio.com***
3. ***http://forum.cqham.ru/viewforum.php ?f=28***
4. ***Skidan@mail.ints.net T03DSP UR3IQO http://users.ints.net/skidan/T03DSP***
5. ***http://www.nitehawk.com/sm5bsz Leif LINARD***
6. ***http://www.flex-radio.com SDR1000 Gerald AC5OG***
7. ***http://www.njqrp.org/mbrproj/9850dds.html***

www.analog.com/en/prod/0,,770_843_AD9850,00.html

http://www.qsl.net/pa3ckr/signalgenerator/

http://www.k6ese.com/DDS_Project.htm

http://ham.kiev.ua/pic/dds_ham2.html

http://www.qsl.net/om3cph/dds/rx.html

http://www.seboldt.net/k0jd/othervfo.html

http://perso.wanadoo.fr/f6itv/p2063001.htm

http://koti.netplaza.fi/~jonverro/ad9854.htm

http://www.labyrinth.net.au/~steve/freq/

http://members.aol.com/Dl4JAL/DDS.html

http://hem.passagen.se/communication/dds.html

8. *Recent Advances in Shortwave Receiver Design Dr. Ulrich Rohde QST Nov 1992 page 53*
5. *RF Design 6/1995*

9. Ultra Low Noise, High Performance, Zero IF Quadrature, Product Detector and Preamplifier-Dan Tayloe N7VE

10. A Software Defined Radio for the Masses, Part 1-4, Gerald Youngblood AC5OG

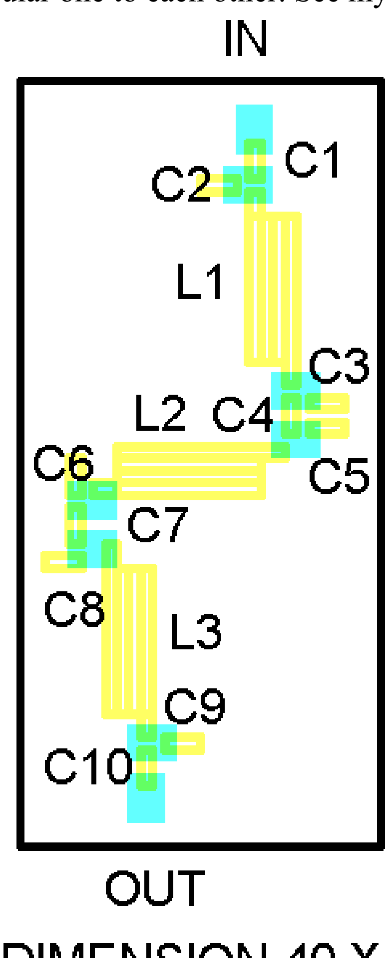
Software LINK for SDR radio receiving and transmitting

1. *www.weaksignals.com WINRAD,SDR0.99*
2. *www.ciaoradio.com*
3. *www.m0kgk.co.uk/sdr*
4. *www.g8jcf.dyndns.org Peter G8JCF*
5. *http://www.nitehawk.com/sm5bsz Leif LINARD*
6. *http://www.flex-radio.com SDR1000 Gerald AC5OG*
7. *dl6iak.ba-karlsruhe.de*

Band Pass Filters for 6m

Dipl ing Tasić Siniša –Tasa YU1LM/QRP

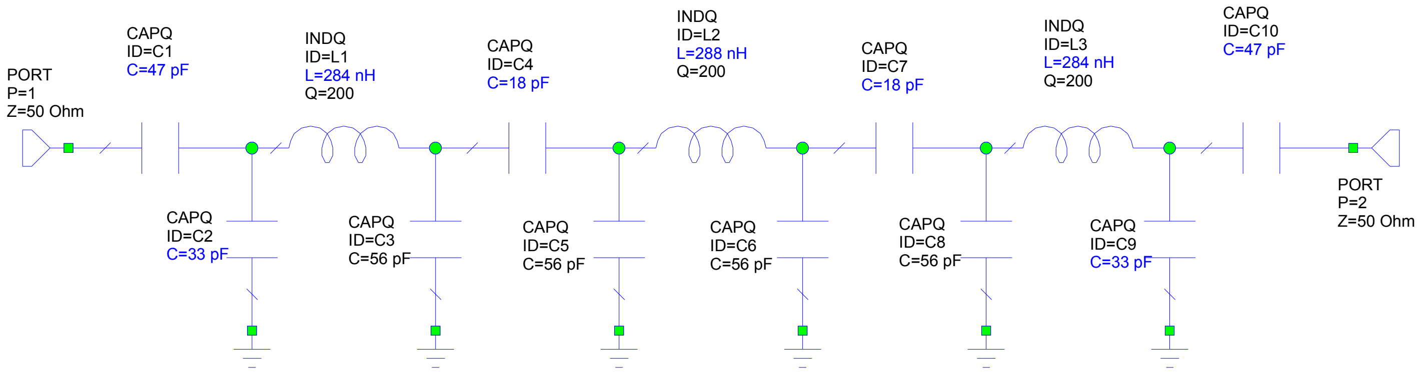
At local HAM forum BalkanDX was discussion about BP (band pass) filters for the 6m few years ago. Here are my proposals band pass filters for 6m band. First filter is with minimum IL (insertion loss) lower than 0.7 dB. This filter is possible to use except in the receiver and also in the transmitter chain. Second filer is with moderate IL loss less than 1.5 dB. The third filter is with max selectivity and IL is less than 2.5 dB. Realization is a very simple and non-critical. Please take care only about physical coils placement. It is necessary to prevent mutual coupling between coils or this coupling has to be minimized. This unwanted coupling will destroy out of band selectivity.
Best way for montage is free space construction but it is possible make a PCB. Take care that coils are perpendicular one to each other. See my proposal down please



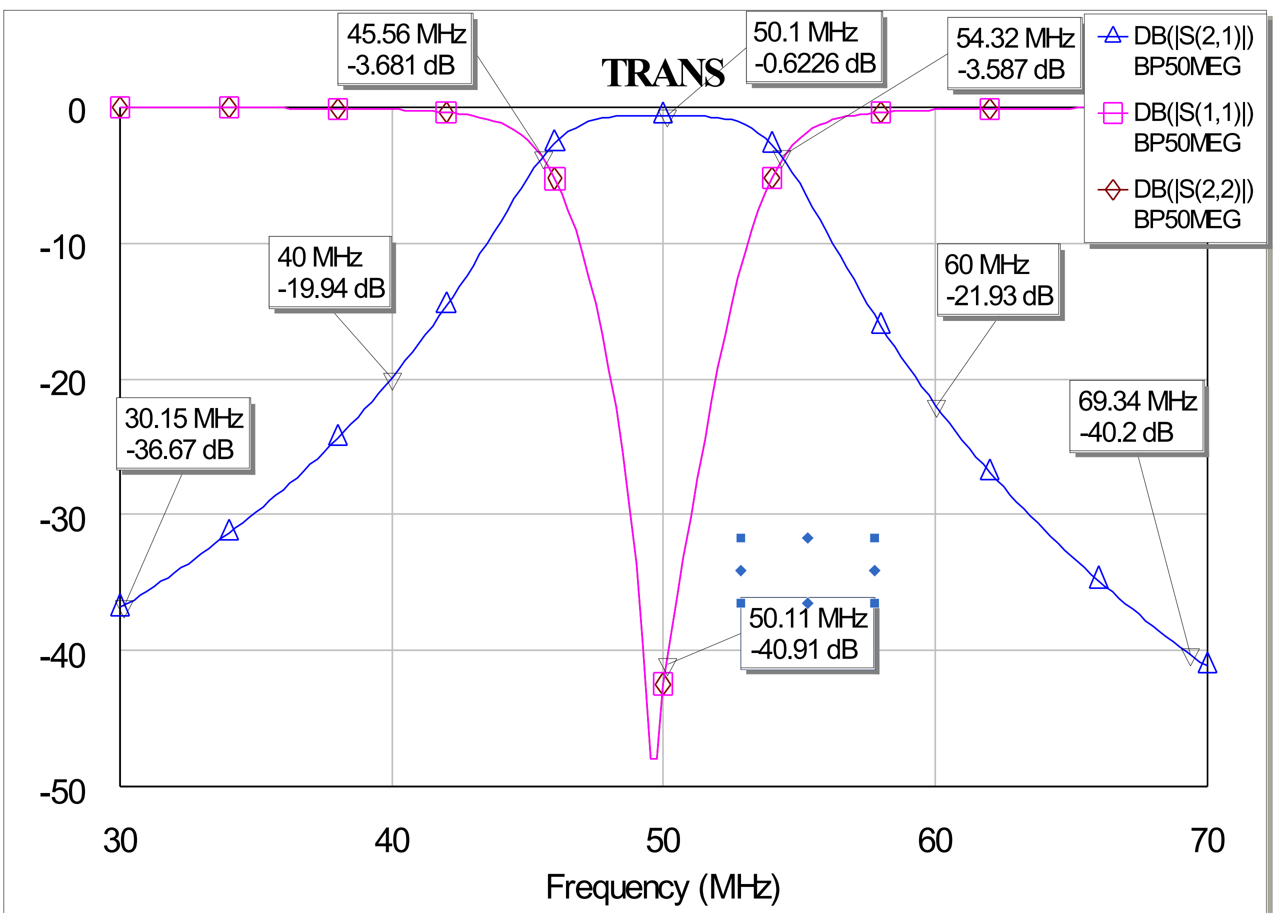
PCB DIMENSION 40 X 80 mm

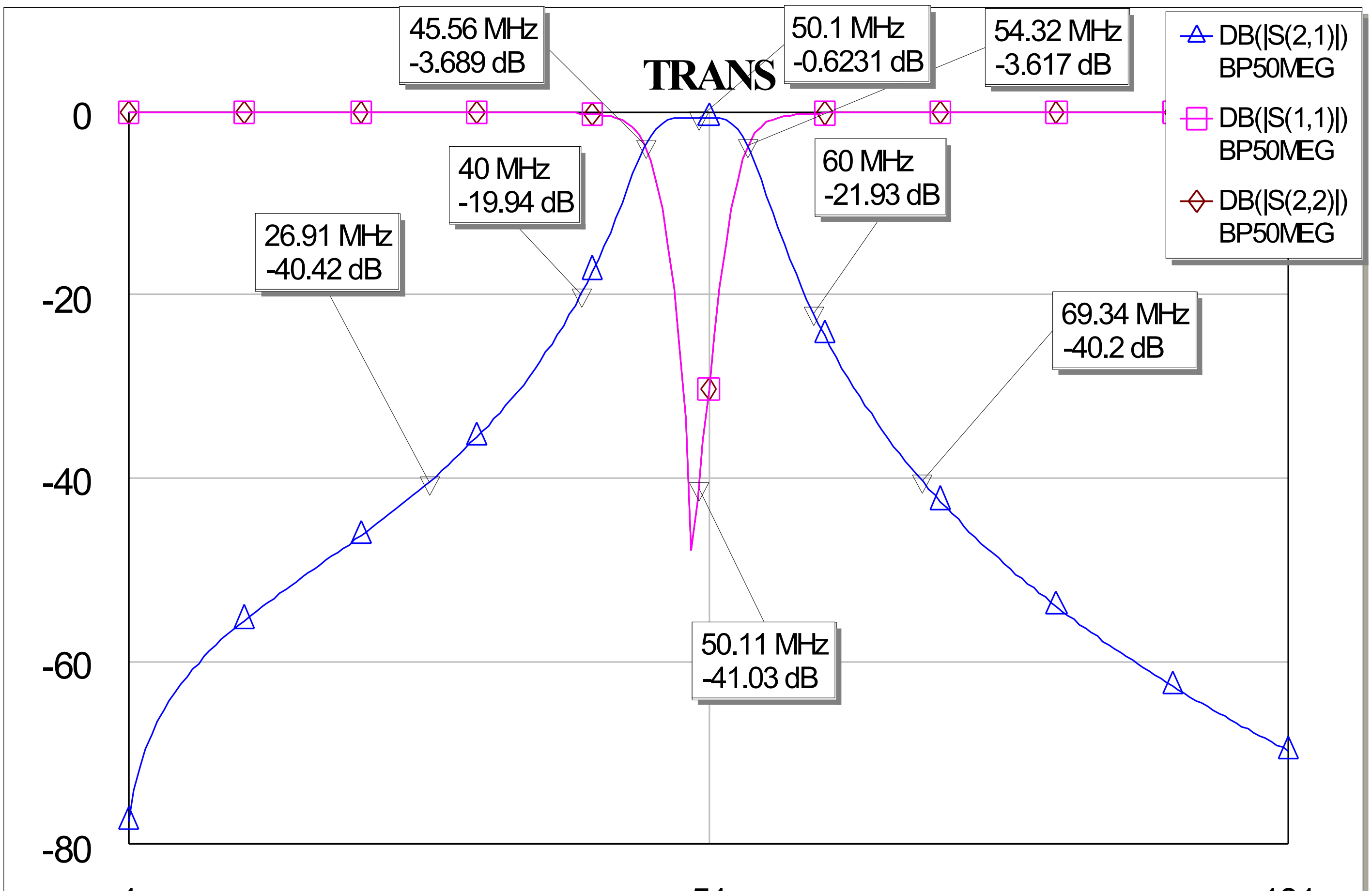
All coils are equal and wound with isolated copper (Cu) wire diameter 1.2 mm (AVG18) without support on body diameter 14 mm. Coils length is 5 mm with 4 turns. For coils with smaller inductivity than 320 nH it is necessary only to make carefully space between wounds.

1. Minimum IL 6 m BP filter –This filter can be at RX input or TX output. BP Bandwidth is 8.7 MHz (-3 dB)



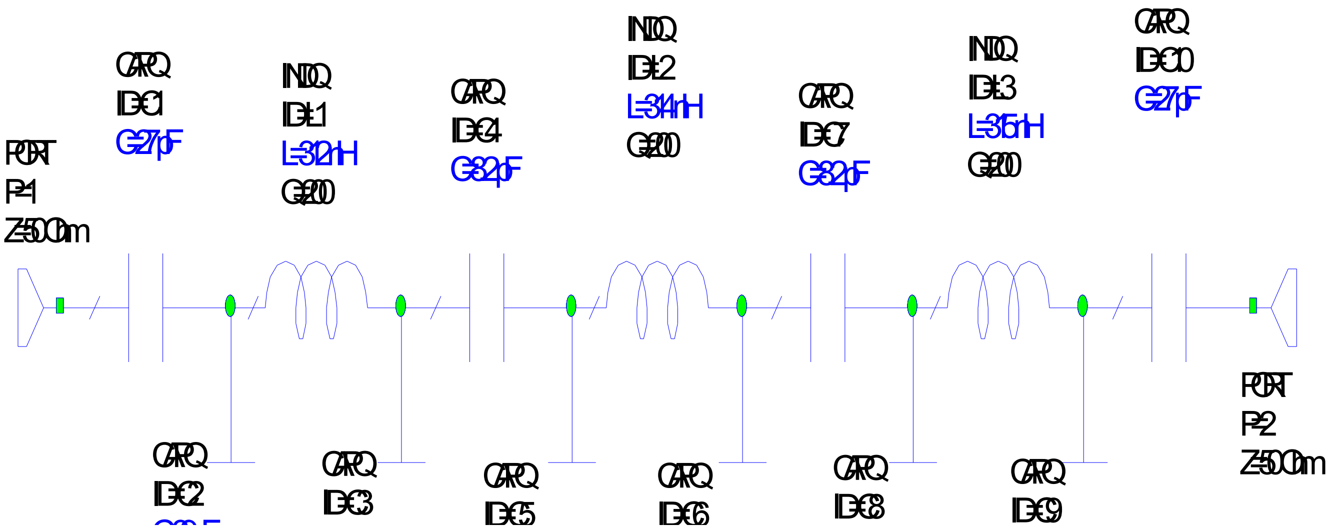
BAND PASS FOR 50 MHz

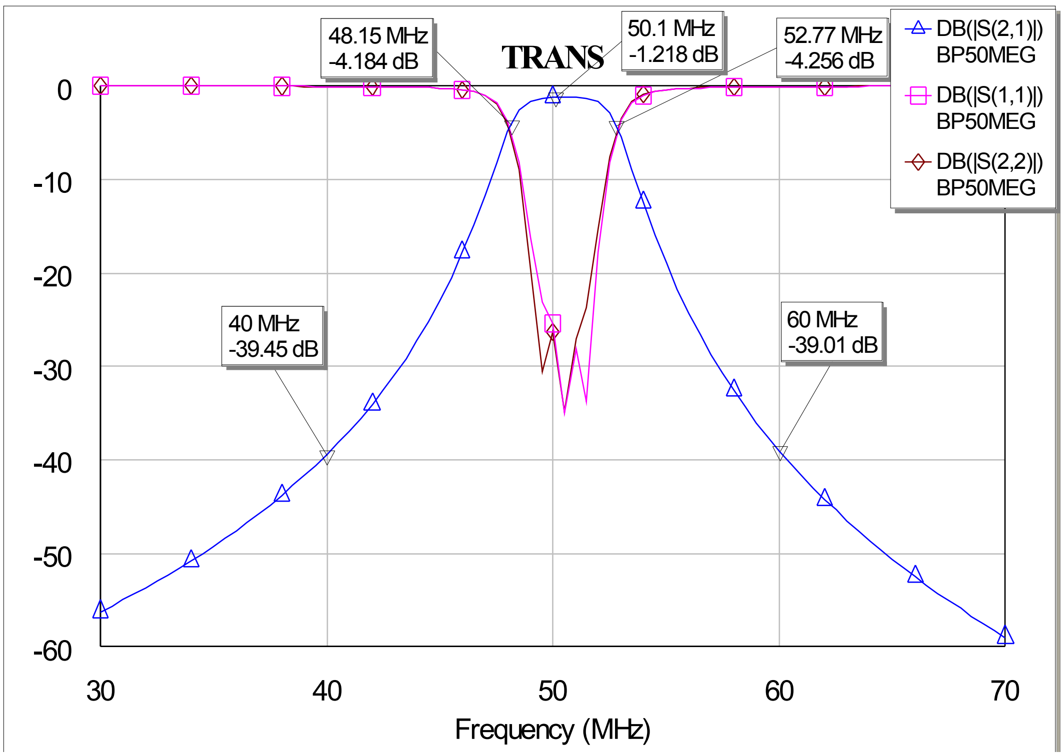


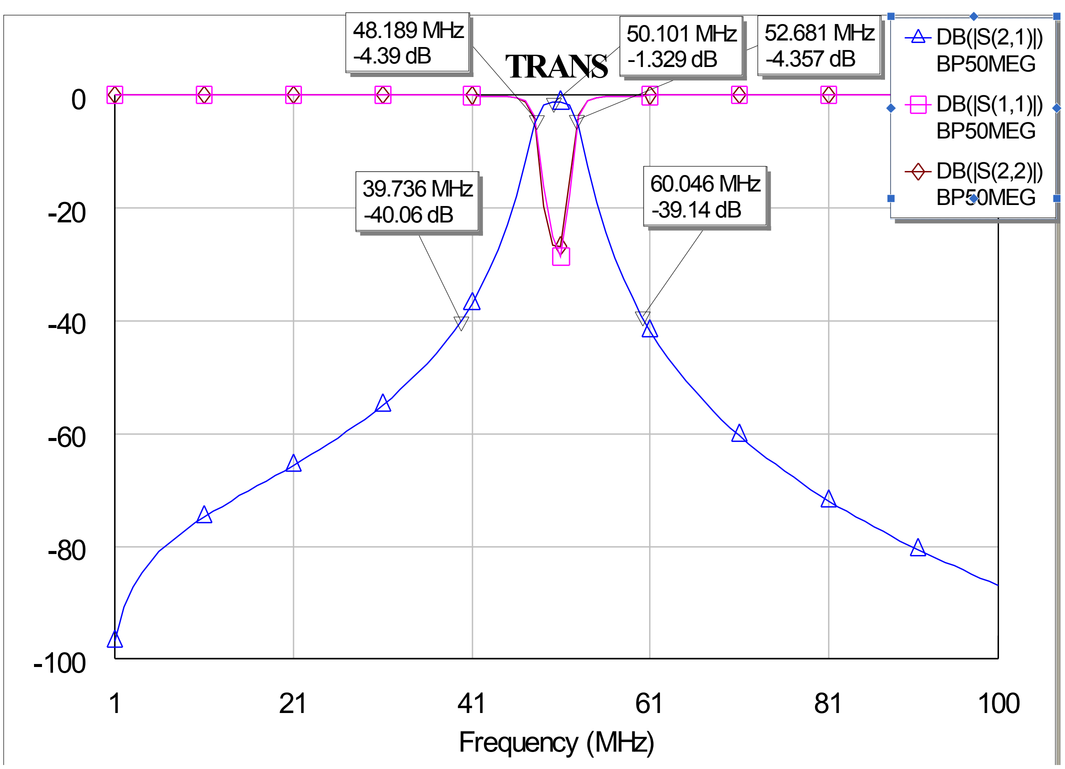


TRANS
45.56 MHz
-3.689 dB
50.1 MHz
-0.6231 dB
54.32 MHz
-3.617 dB
40 MHz
-19.94 dB
60 MHz
-21.93 dB
26.91 MHz
-40.42 dB
69.34 MHz
-40.2 dB
50.11 MHz
-41.03 dB
DB(|S(2,1)|)
BP50MEG
DB(|S(1,1)|)
BP50MEG
DB(|S(2,2)|)
BP50MEG
0
-20
-40
-60
-80

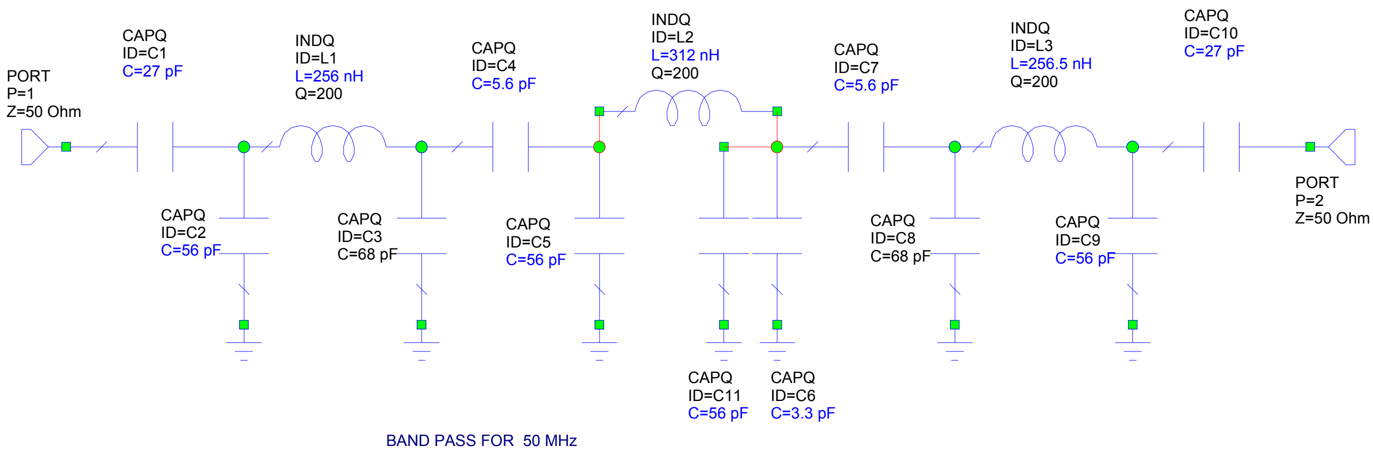
2. BP filter for 6 m with moderate IL. This filter can be used in receiver and transmitter chain also. Bandwidth is 4.6 MHz (-3 dB)

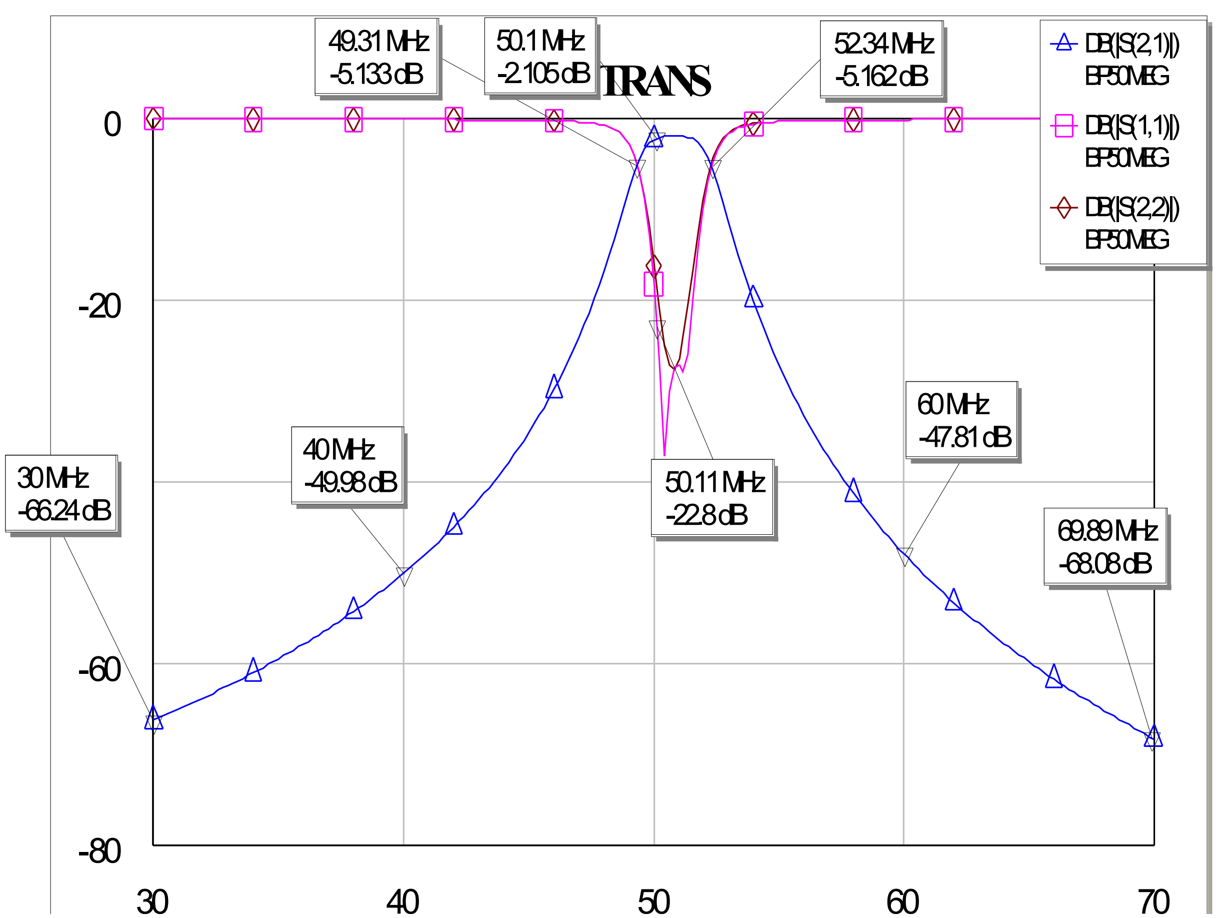


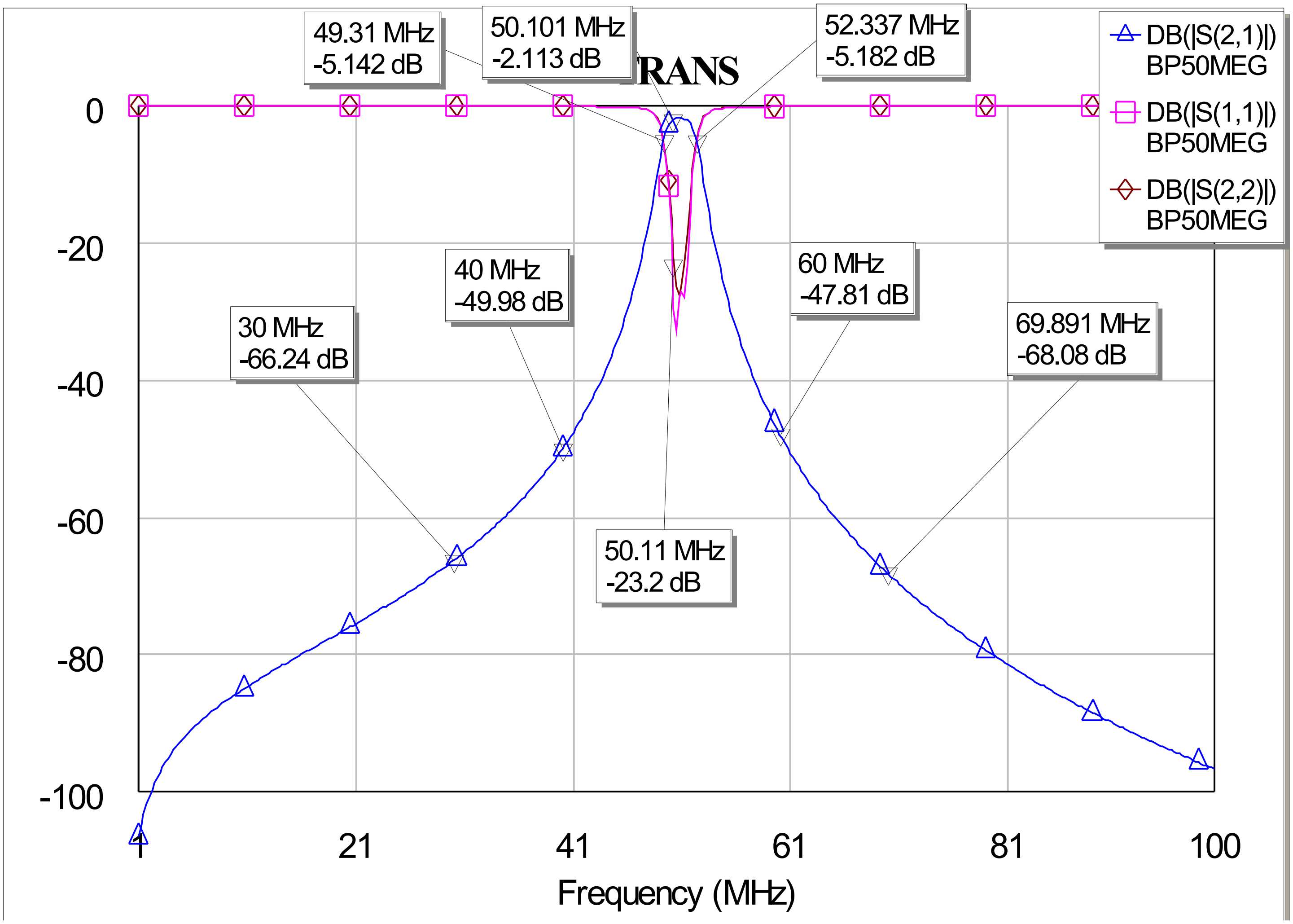

48.15 MHz
-4.184 dB
TRANS
50.1 MHz
-1.218 dB
52.77 MHz
-4.256 dB
DB(|S(2,1)|)
BP50MEG
DB(|S(1,1)|)
BP50MEG
DB(|S(2,2)|)
BP50MEG
40 MHz
-39.45 dB
60 MHz
-39.01 dB
0
-10
-20
-30
-40
-50
-60
30
40
50
60
70
Frequency (MHz)


48.189 MHz
-4.39 dB
TRANS
50.101 MHz
-1.329 dB
52.681 MHz
-4.357 dB
DB(|S(2,1)|)
BP50MEG
DB(|S(1,1)|)
BP50MEG
DB(|S(2,2)|)
BP50MEG
39.736 MHz
-40.06 dB
60.046 MHz
-39.14 dB
0
-20
-40
-60
-80
-100
1
21
41
61
81
100
Frequency (MHz)

3. Very narrow 6m BP filter, adjustment for this filter realization is relatively critical. Filter's bandwidth is 3 MHz (-3 dB).







Practical BP realization gave results similar compared to this simulations obtained curves. I wish you successfully realization BP filters for 6m.

VY 73/72 Tasa YU1LM/QRP
Belgrade, September 2006

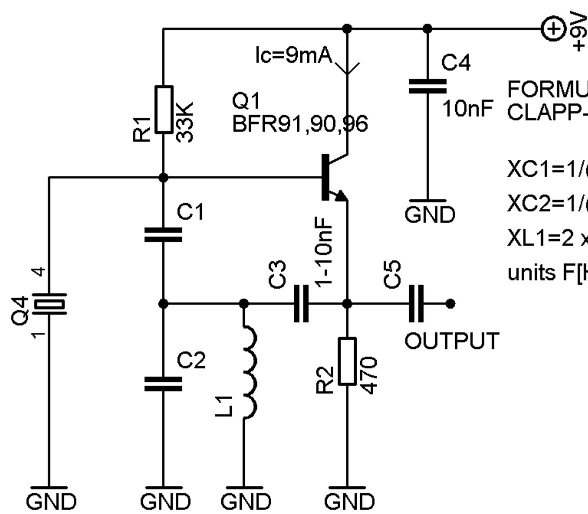
An universal HF / VHF Low Noise Crystal Oscillator with Switching 4 Crystal Unit Possibility – Make it Simple as Possible with Outstanding Performances

Dipl. Ing Tasić Siniša-Tasa YU1LM/QRP

I made great number different oscillators, crystal fundamental and harmonic mode and VCO starting from KHz range to the GHz region in past. Some my designs ware low noise, ultra low noise, some broad-band, some narrow-band, oven…… My design motto is and it was make it simple as possible with outstanding performances.

This design started when I was decided to make LO (local oscillator) with DDS IC AD9850 few years ago. I was looking through many articles and book trying to find some good and simple design for REF DDS oscillator. In reference 2 I find very interesting schematic for Clapp-Guriett harmonic (overtone) oscillator in VHF range 30 -200 MHz. I made similar design few time early but I didn't examining seriously like I did now. I started classic oscillator design with freeware software ANSOFT serenade SV8.7. With CAD help I find initial values for oscillator components. Freeware Serenade SV8.7 hasn't possibility oscillator and nonlinear analyses. My good friend Steven A. Thompson offered me help in oscillator design with "full" Serenade 8.7 version. I have to bring him endless acknowledge for great effort in correction my design and production really nice screen shots down in text.

I tried design with classic BJT transistors series BFR90, BFR91, BFR96 and at the similar way oscillator was working SMD transistor BFR93 also. There is no big difference between scillators performances realized with different transistor except that some samples BFR90 wasn't able to give the same output power as other (power was lower for 1-2 dB) can. It is very important to say that I haven't possibility to check such low oscillator phase noise and maybe it is too much optimistic predicted. From my previously experience oscillator phase noise close to carrier in region 0-200,400 Hz around depend mainly from how it is suppressed power supply noise. Predicted oscillator output waveform I checked with 300 MHz oscilloscope and they were very similar to predicted simulation screen shoot. Output spectrum at SA(spectrum analyzer) were very close to predicted. This facts gave me belief that there are good correspondence between design and realization. First I am giving you basic schematics for calculation without output drive transistor and additional LP (low pass).

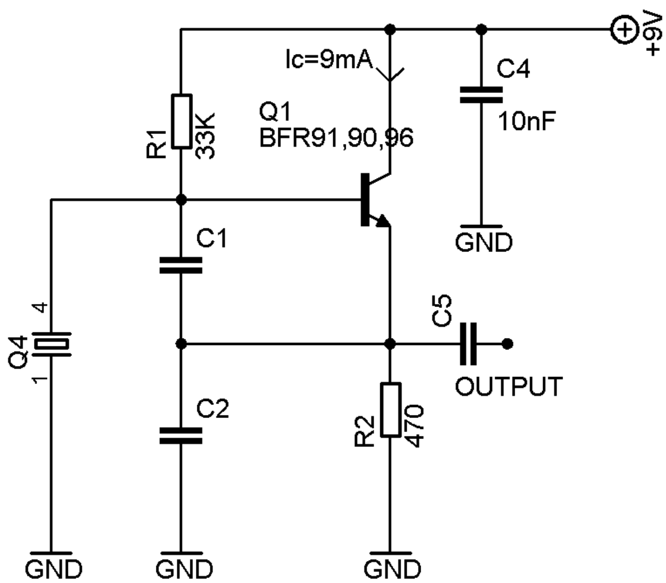


FORMULAS FOR CALCULATION
CLAPP-GURIETT OSCILLATOR

XC1=1/(2 x Pi x F x C1) = 25 - 30 OHm
XC2=1/(2 x Pi x F x C2) = 25 - 40 OHm
XL1=2 x Pi x F x L1 = 60 - 70 OHm
units F[Hz],C[F],L[H]

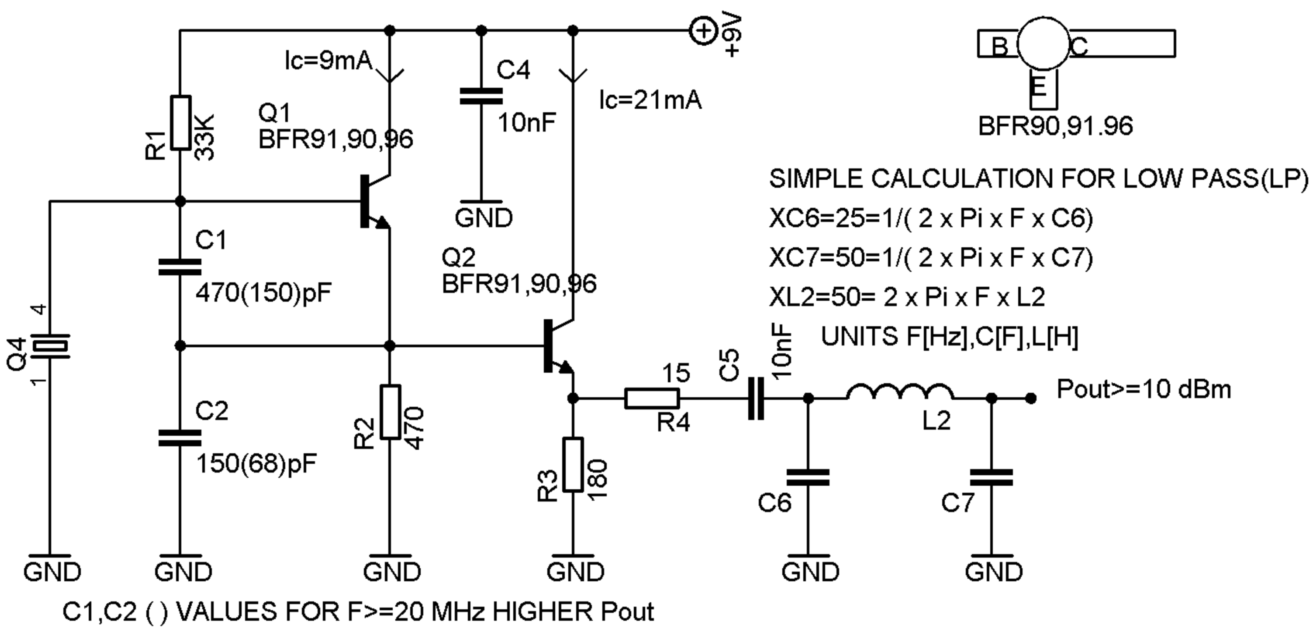
Output low pass filter is very important for my receivers with diode mixer as demodulator and non optimum SDR receivers like DR2C... For them it is very important that LO drive square or sinusoidal have close 50/50 ratio for optimal work. Non optimal LO drive lead SDR RX demodulator to a lot of problems like harmonic receiving are. Other my SDR receivers which have FF Flip-Flop at LO input are not sensitive to the signal shape except input level. Of course good LO drive shape will help us to obtain optimum performances from RX/TX and

TRCV. The Clapp-Guriett oscillator can work with adequate elements from few MHz to 200 MHz. This oscillator is possible simplify transforming it to Colpitts oscillator for Quartz xtal fundamental mode to 30 MHz see picture down

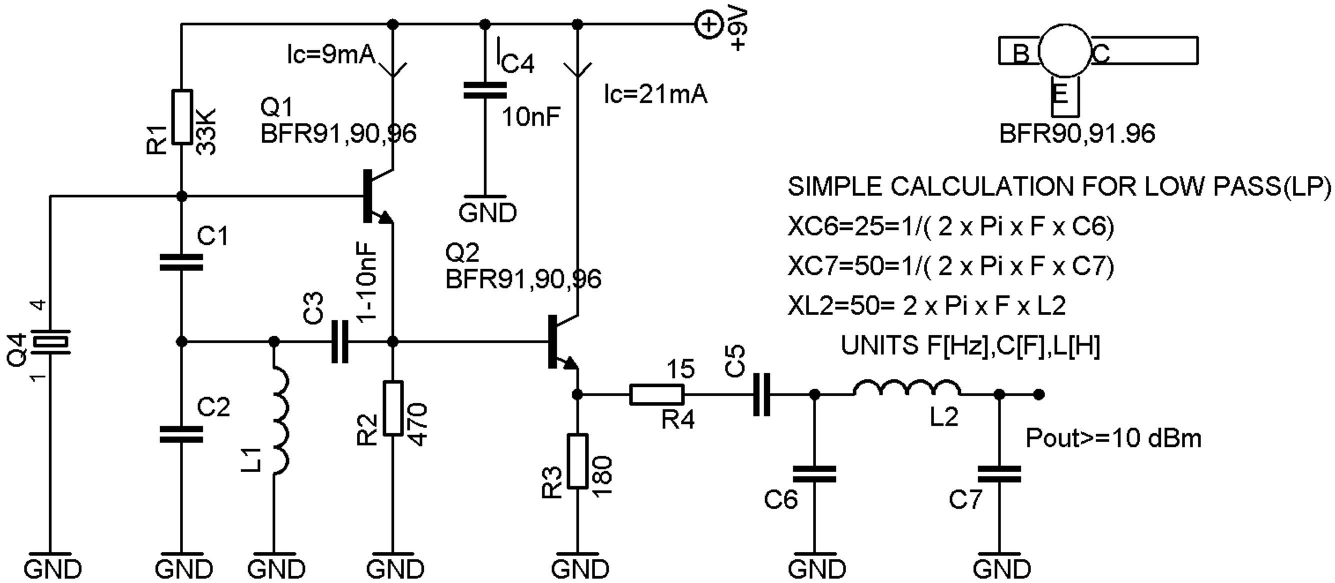


CLAPP-GURIETT OSCILLATOR TRANSFORMED TO COLPITTS OSCILLATOR
FOR XTAL FUNDAMENTAL FREQUENCIES MODE F<=30 MHz

Oscillator transistors have very high Ft transient frequency in region 4-6 GHz. To prevent unwanted UHF oscillation it is very important that all components leads including transistors are short as possible. If this unwanted oscillation have happened after all precautions solder small classic size capacitor 10-33 pF or SMT 100pF from bottom side close to transistor collectors to the ground.

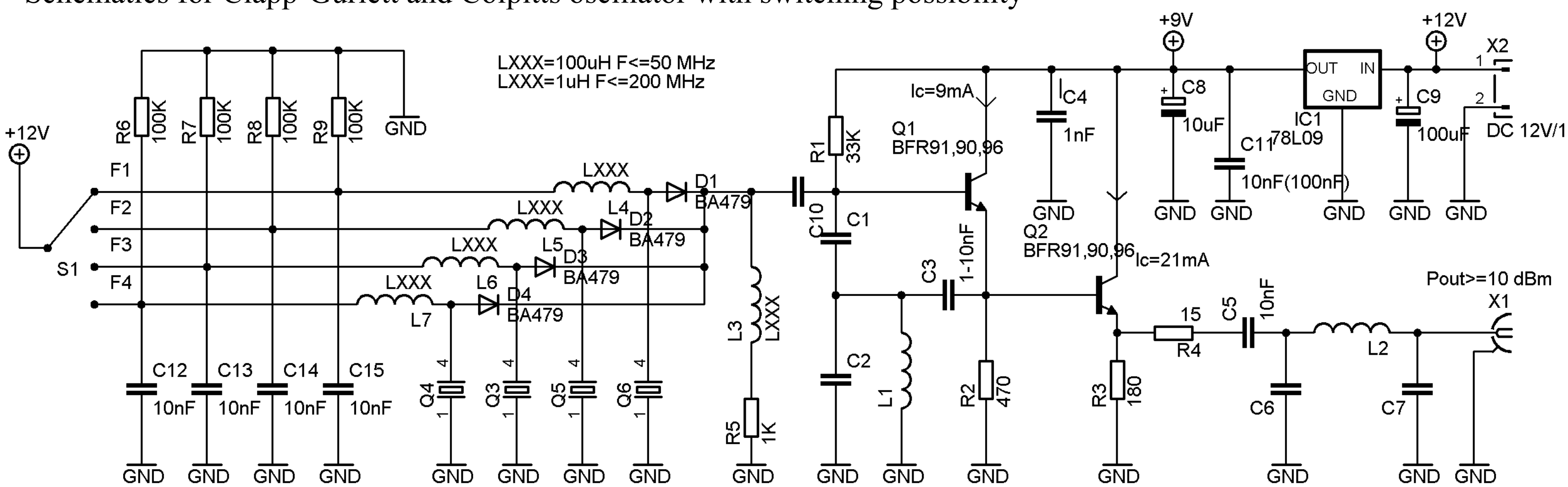


HF(2-30 MHz) COLPITTS OSCILLATOR WITH BUFFER STAGE

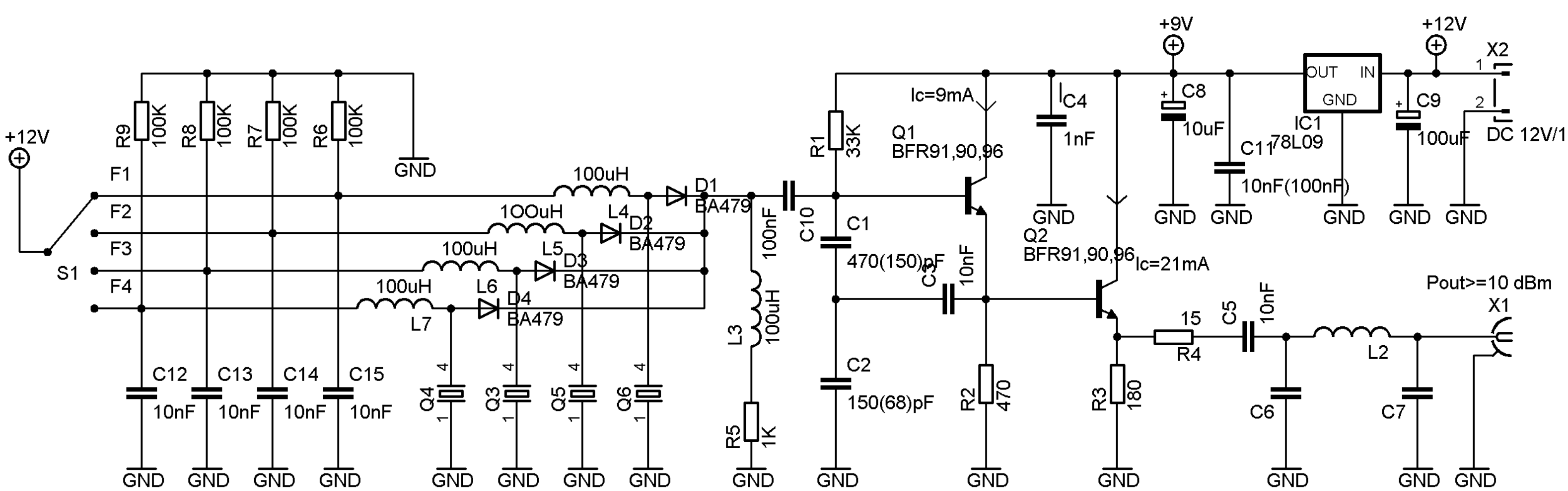


CLAPP-GURIETT OSCILLATOR WITH BUFFER STAGE

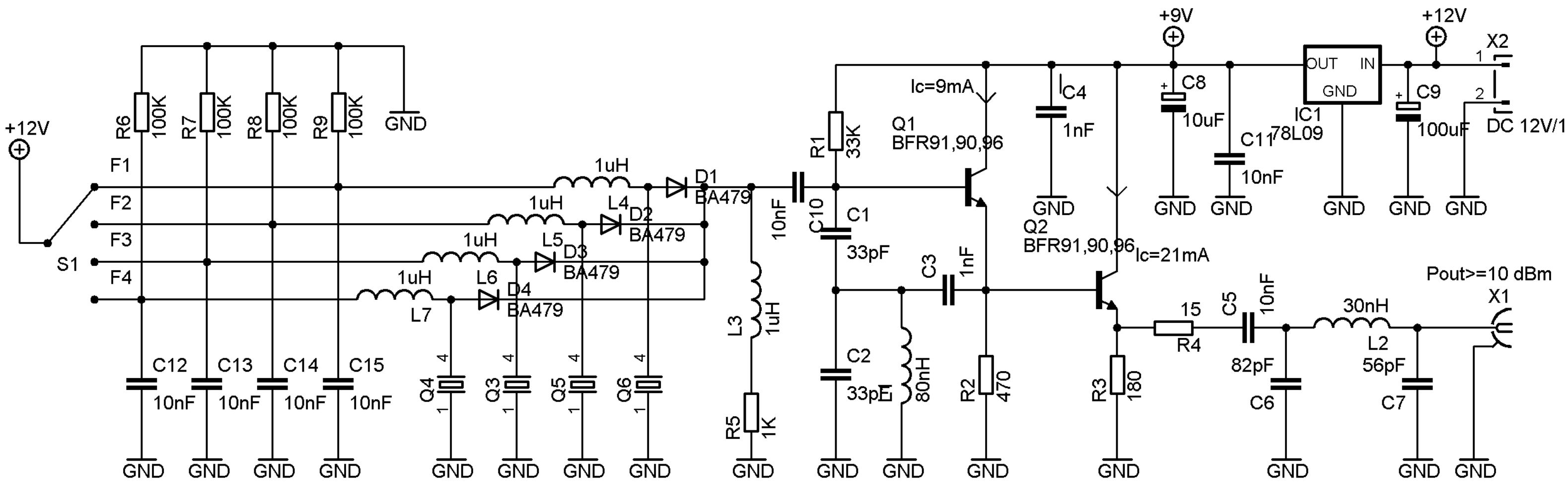
Schematics for Clapp-Guriett and Colpitts oscillator with switching possibility



CLAPP-GURIETT OSCILLATOR WITH BUFFER STAGE AND XTAL SWITCHING



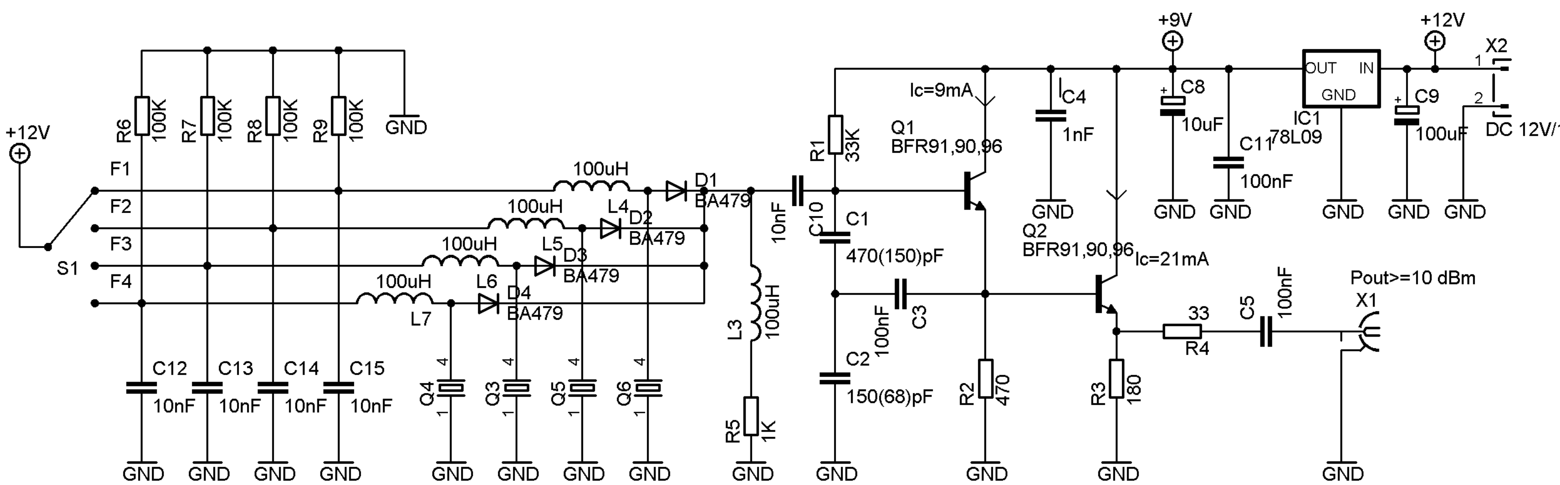
COLPITTS OSCILLATOR F<=30 MHz WITH BUFFER STAGE, LOW PASS AND XTAL SWITCHING



L1=6 TURNS SELF SUPORTED COIL ID=5mm CU WIRE 1mm Qo=110

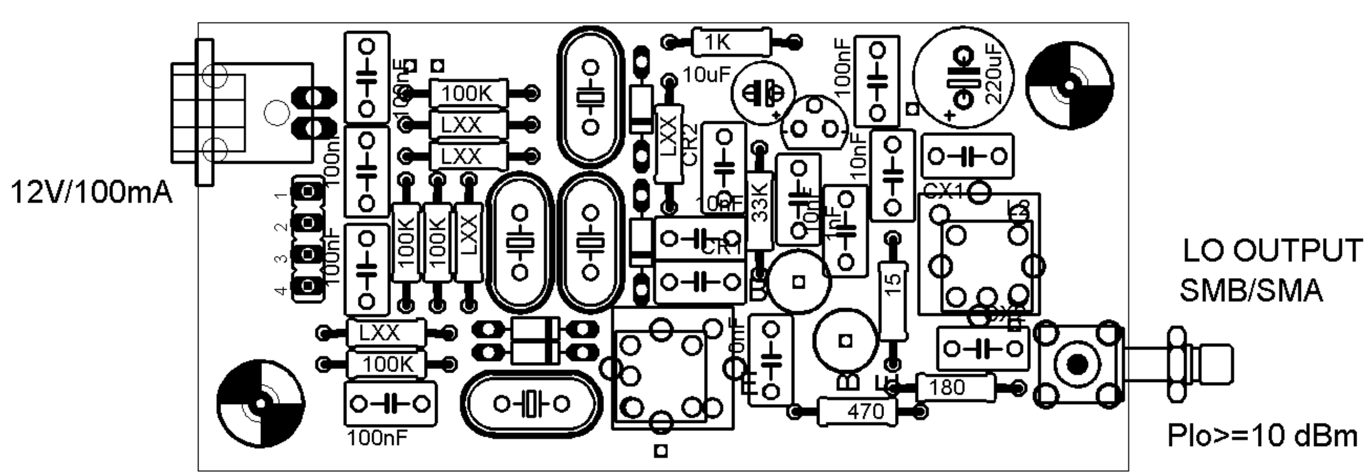
L2=3 TURNS SELF SUPORTED COIL ID=5mm CU WIRE 1mm Qo=110

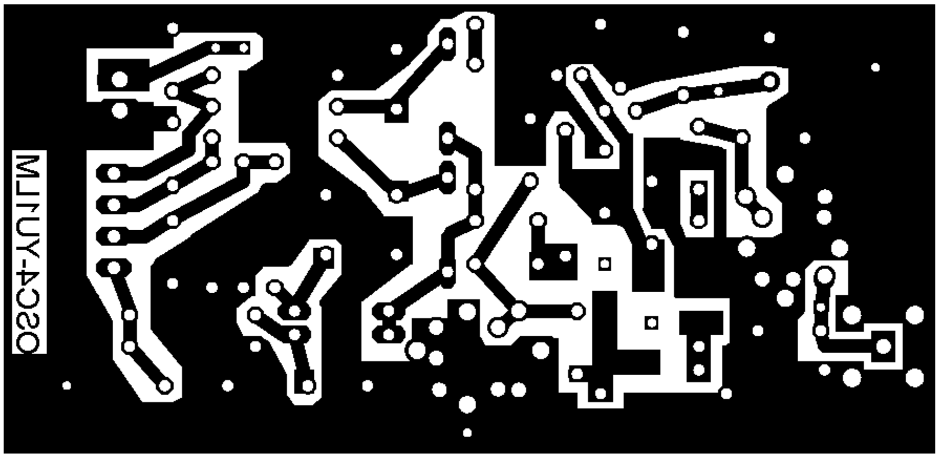
144 MHz CLAPP-GURIETT OSCILLATOR WITH BUFFER STAGE AND XTAL SWITCHING



HF COLPITTS OSCILLATOR WITH BUFFER STAGE WITHOUT LOW PASS AND XTAL SWITCHING

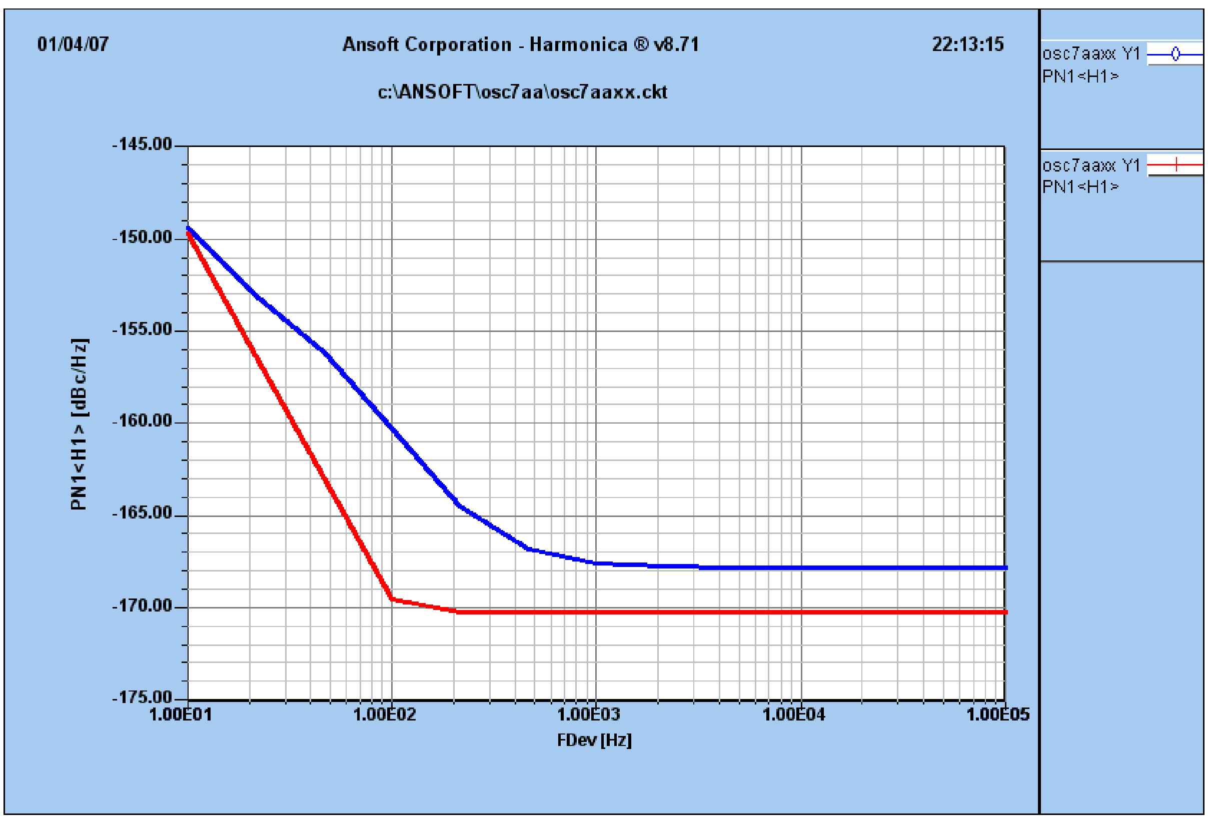
PCB and parts placement for OSC4 are at pictures down



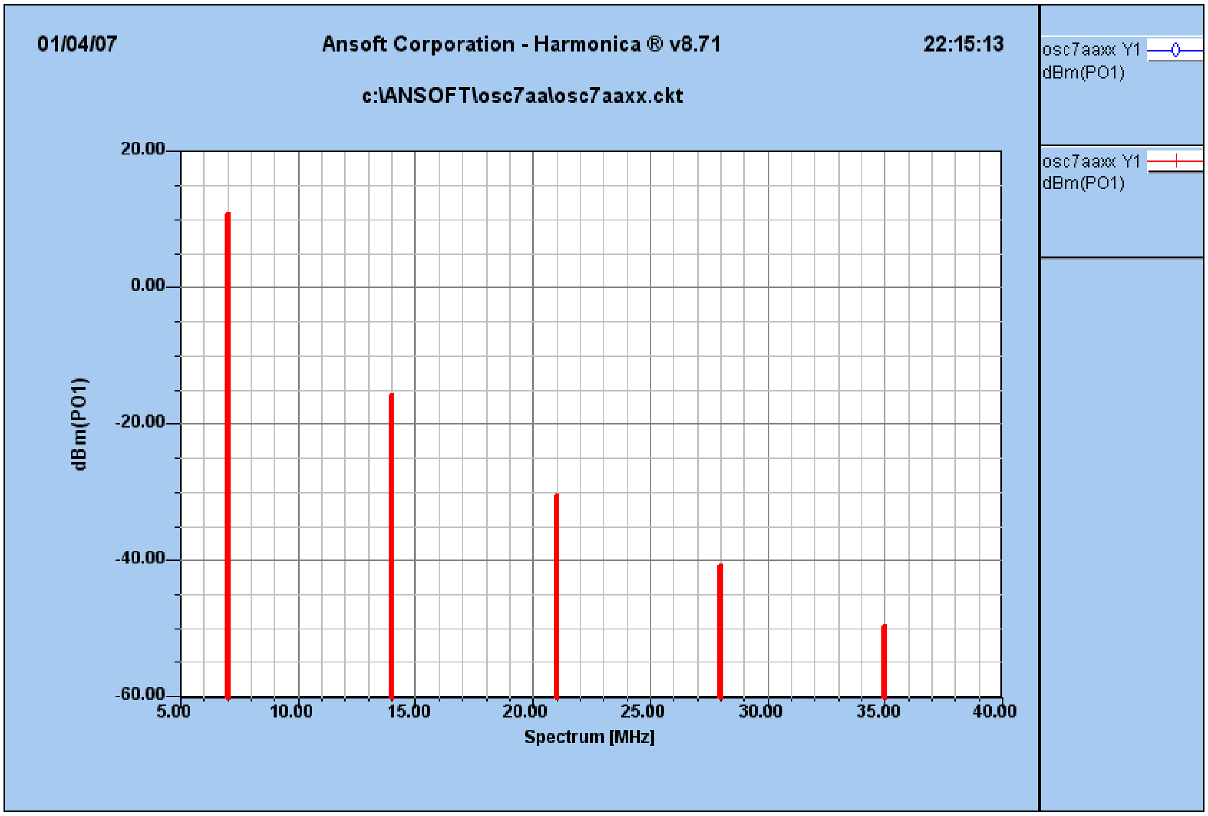


Single side PCB for OSC4 dimensions are 75 x 35 mm

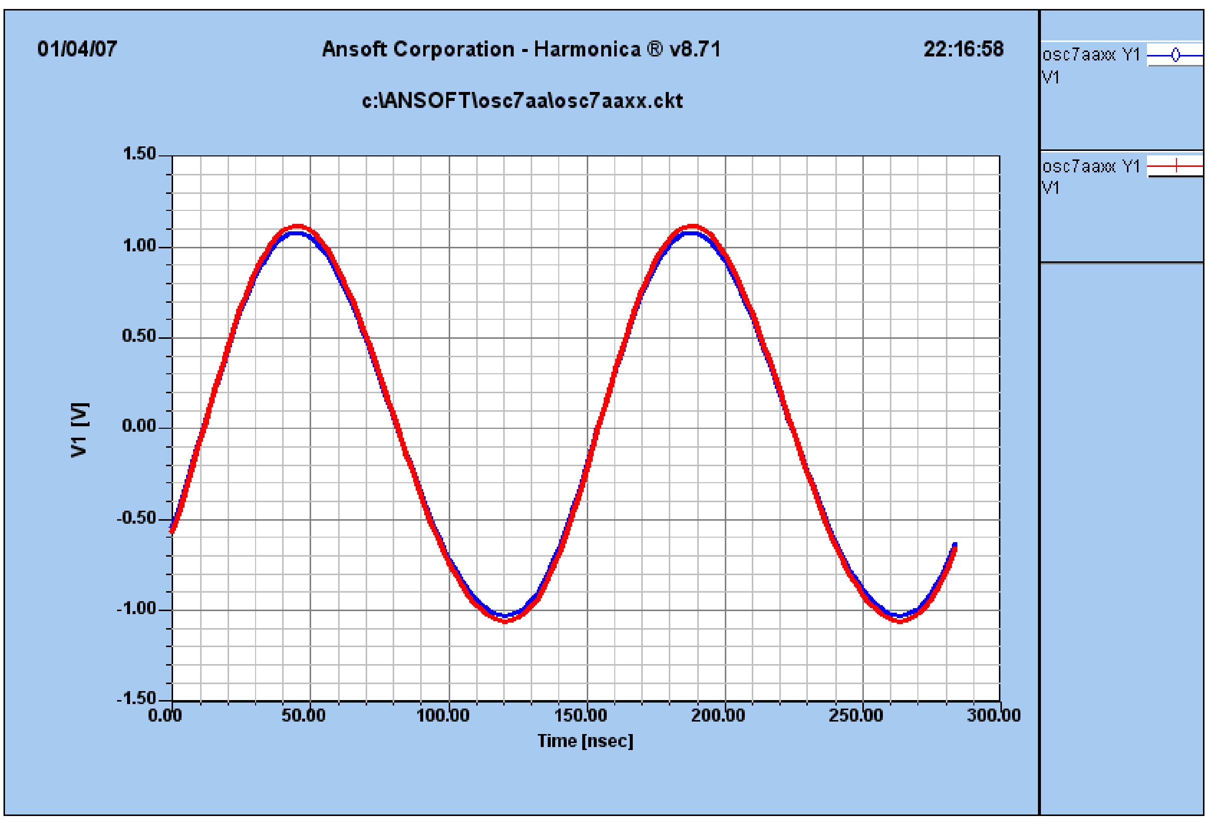
Some practical hints are. Drill holes with borer 5 mm for transistor BFR… soldering from bottom side. Coils L1,L2 are self supported
REF 120 MHz oscillator for mine DDS have very good stability +/- 20 Hz after warm up period from 30 min. After that stability stay in range +/- 5 Hz for hour or better what is excellent result Qo of used crystal in oscillator was 80 000!!!!



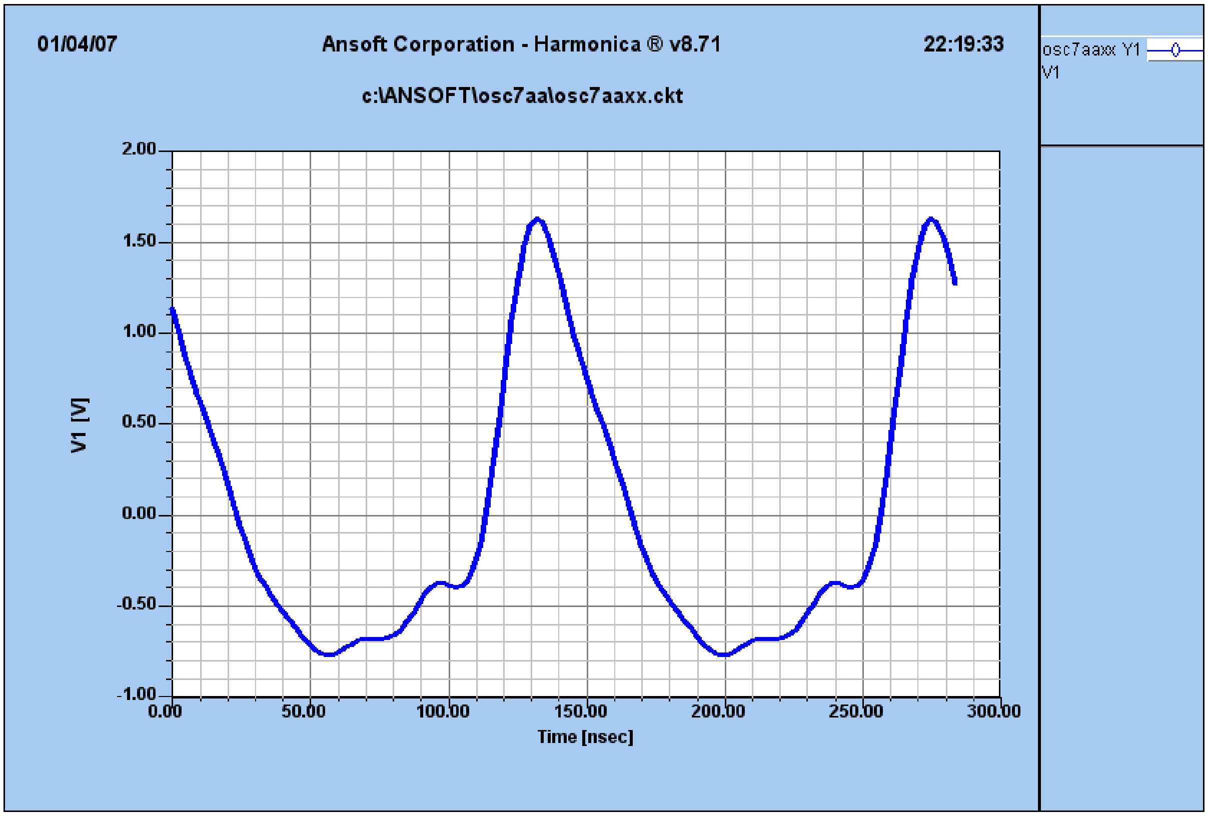
Oscillator phase noise 7MHz (simulation) blue line is single oscillator without switching diodes (red line) with switching diodes Quartz Qo=60000



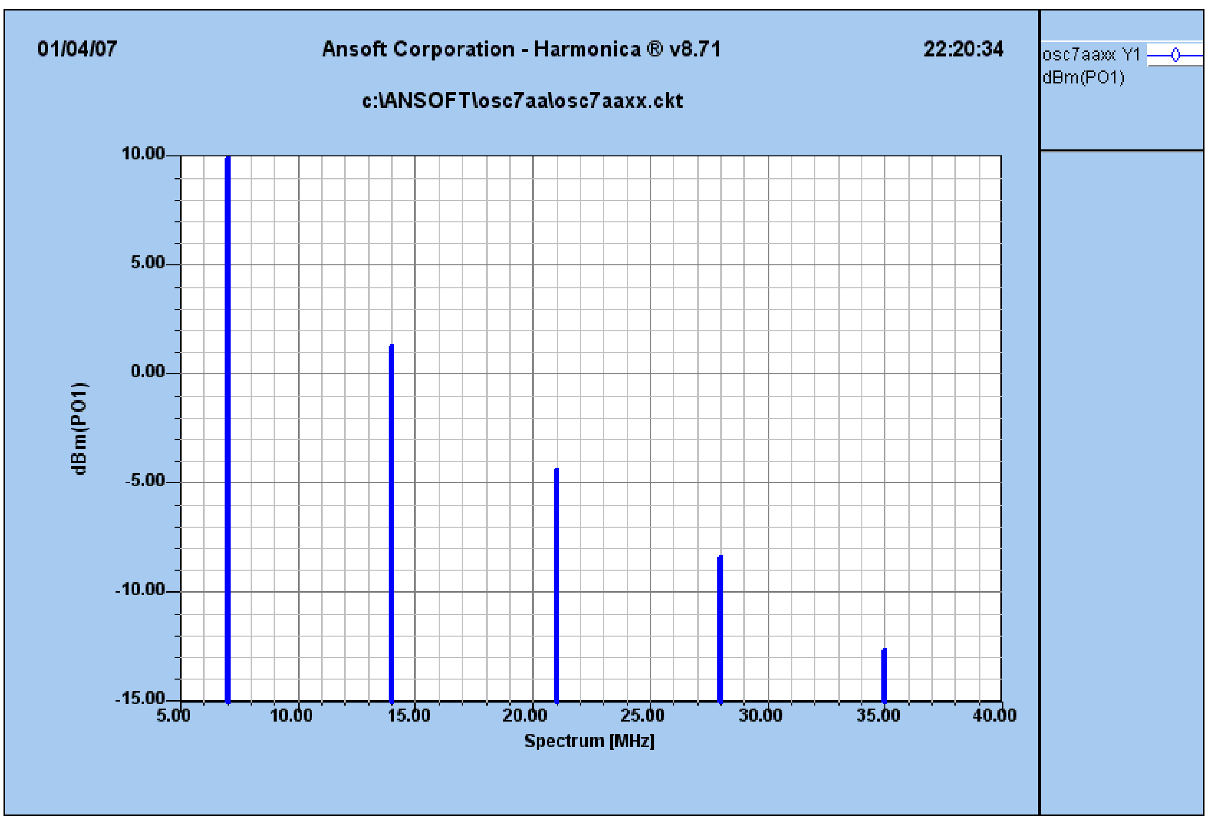
Output spectrum LP elements C6=1nF L2=1uH C7=820 pF



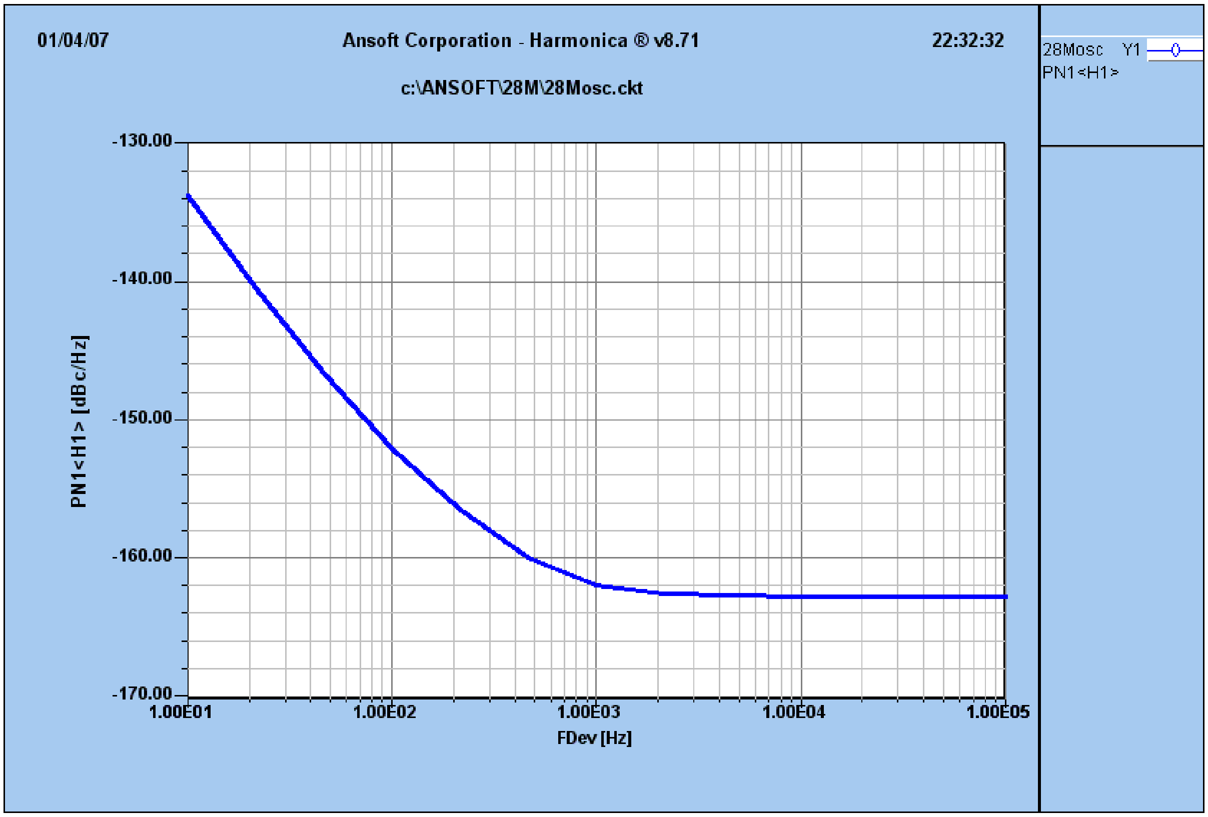
Output waveform at 50 Ohms with LP filter



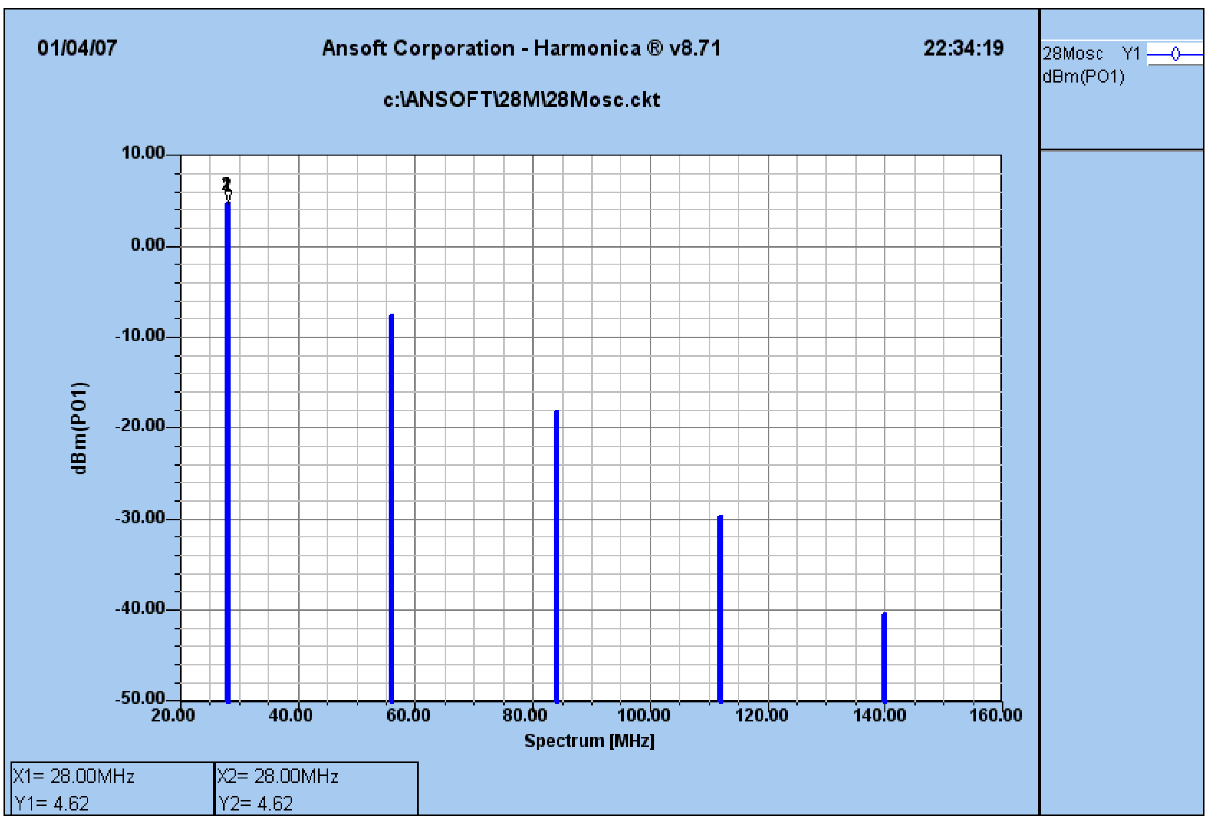
Output waveform without LP R4=33 ohms for better output match



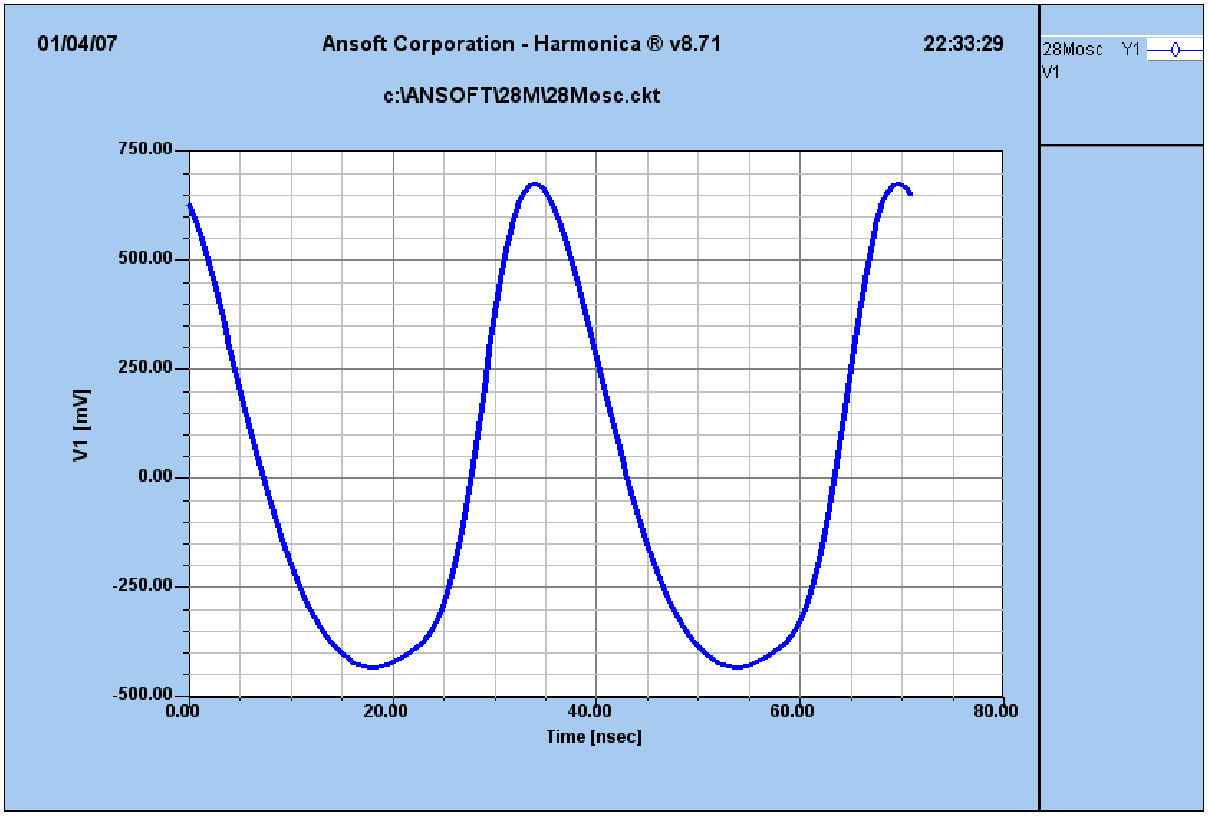
Output spectrum without LP R4=33 Ohms



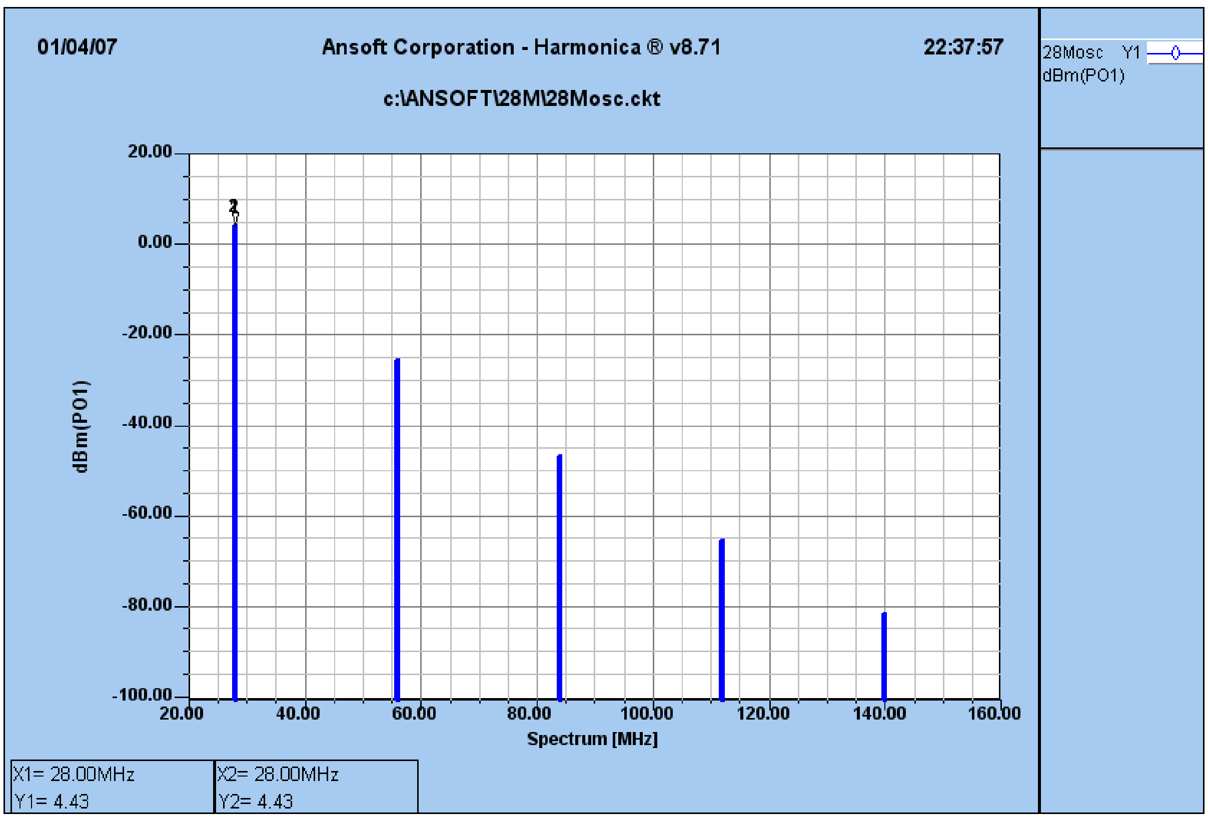
Oscillator phase noise for 28 MHz xtal Qo=60000 LP 220pF 220pF 1500Nh



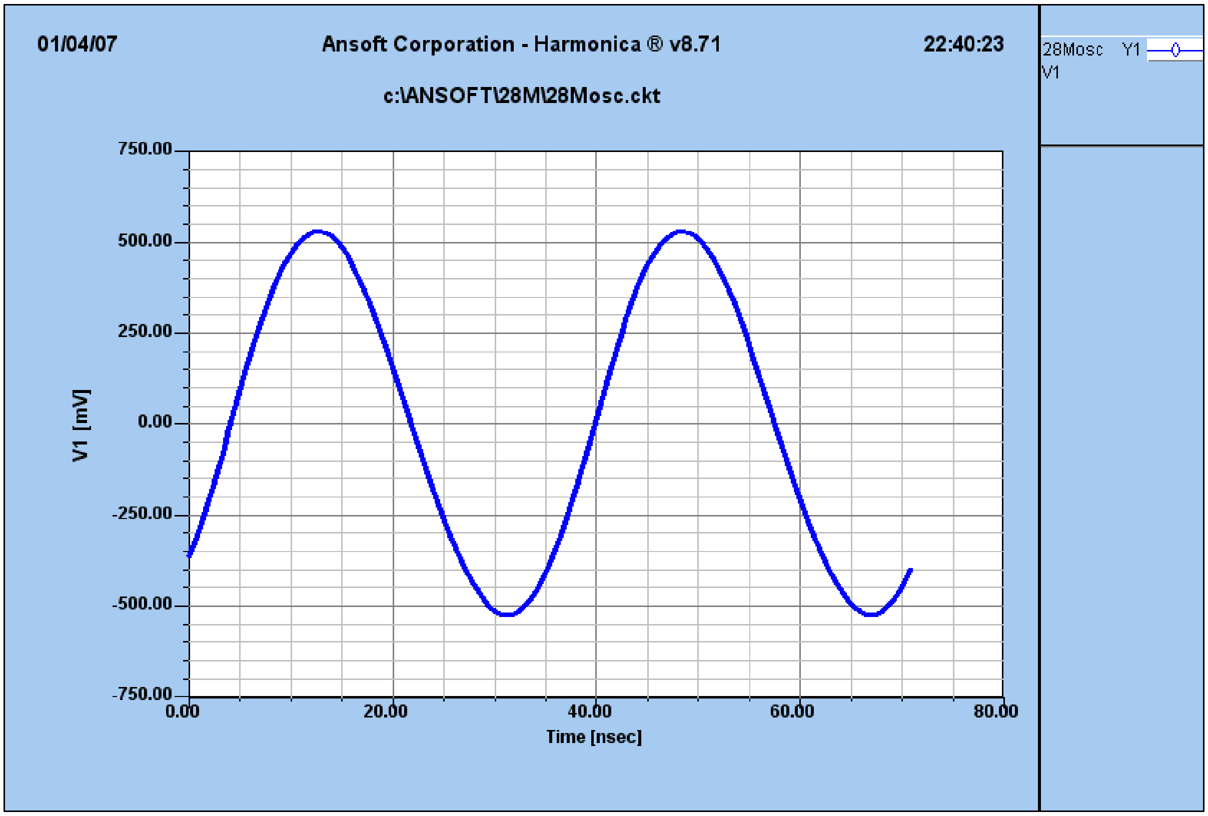
Output spectrum 28 Mhz without LP



Output waveform without LP

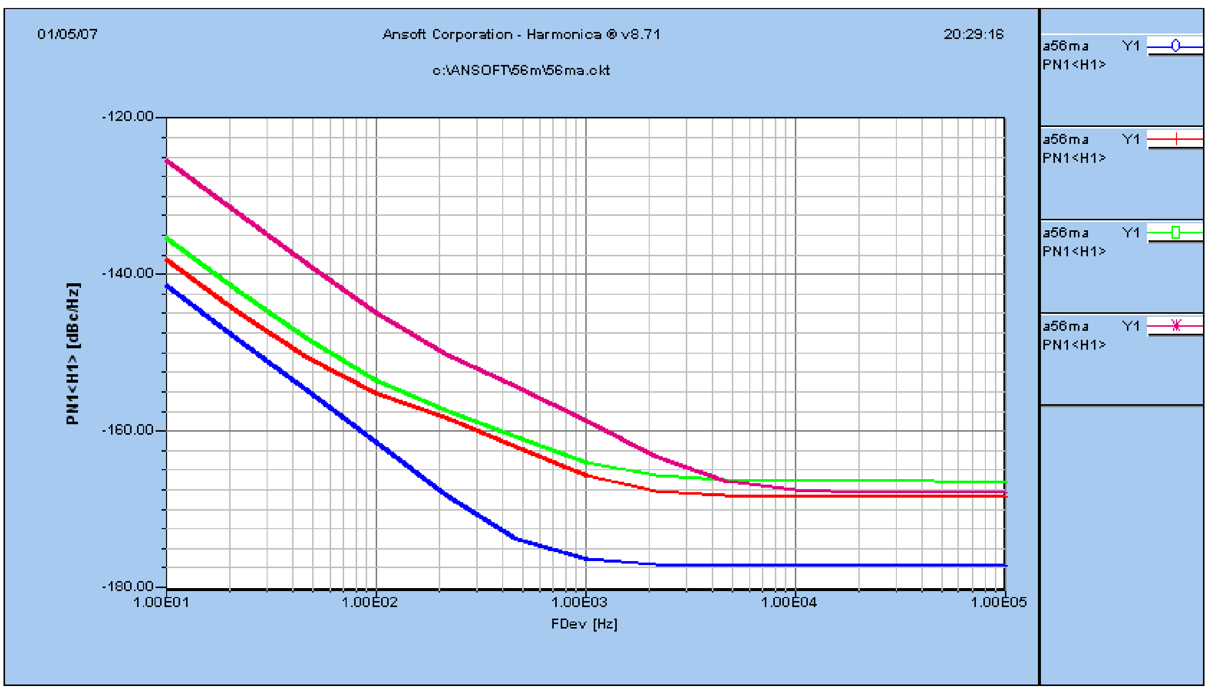


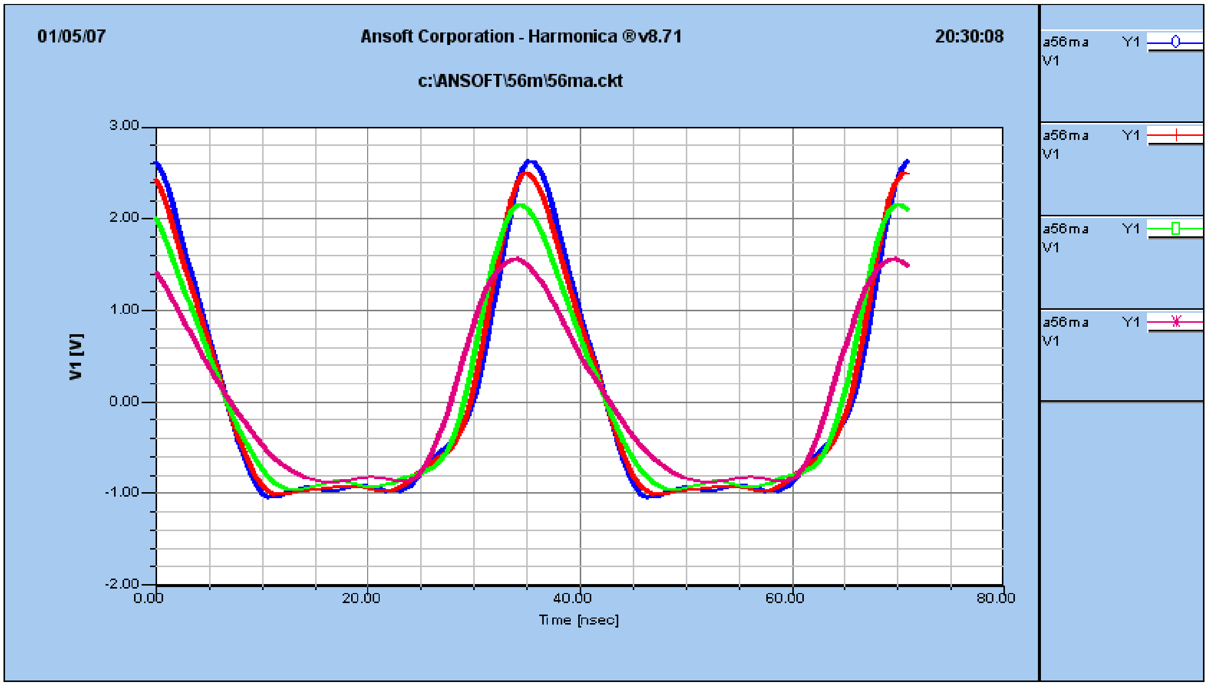
Output spectrum with LP C6=330 pF L2=220nH C7=220pF



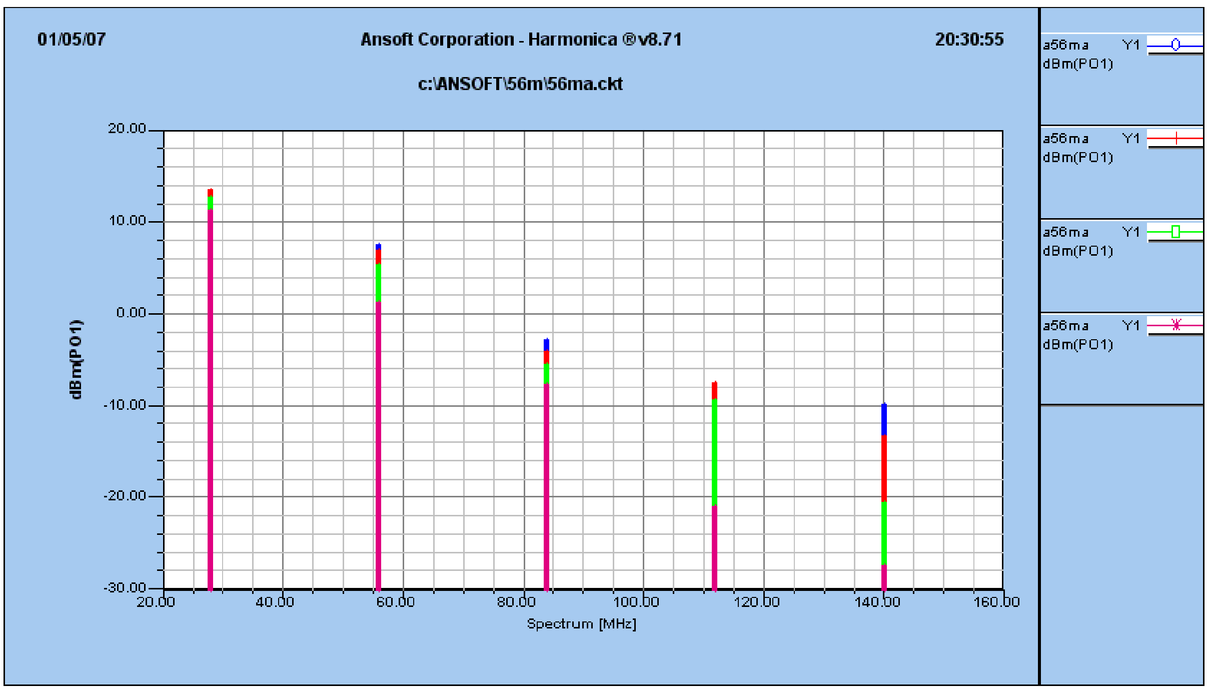
Output spectrum with LP

I changed feedback values in Colpitts 28 MHz oscillator to obtain higher output power. Phase noise change starting from Qo=80000(blue) to 20000(pink) trace in 20 000 steps.
Feedback capacitors are C1=150 pF and C2=68 pF oscillator phase noise



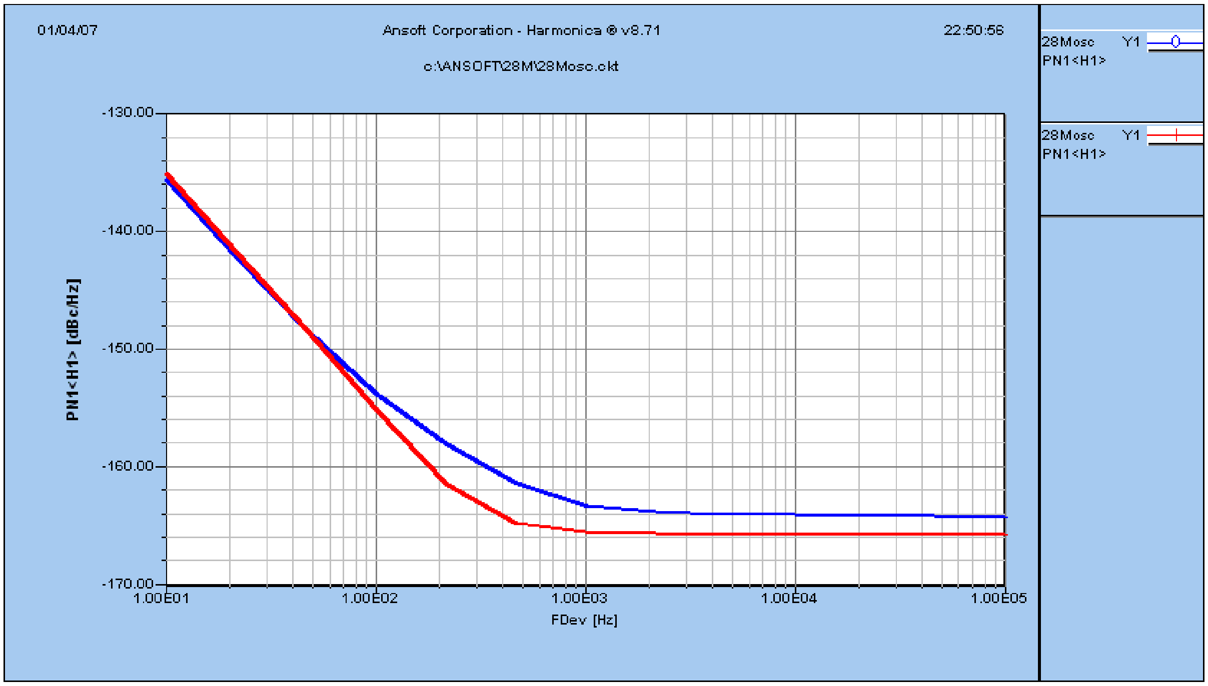


Output waveform changes with Qo change without LP at output

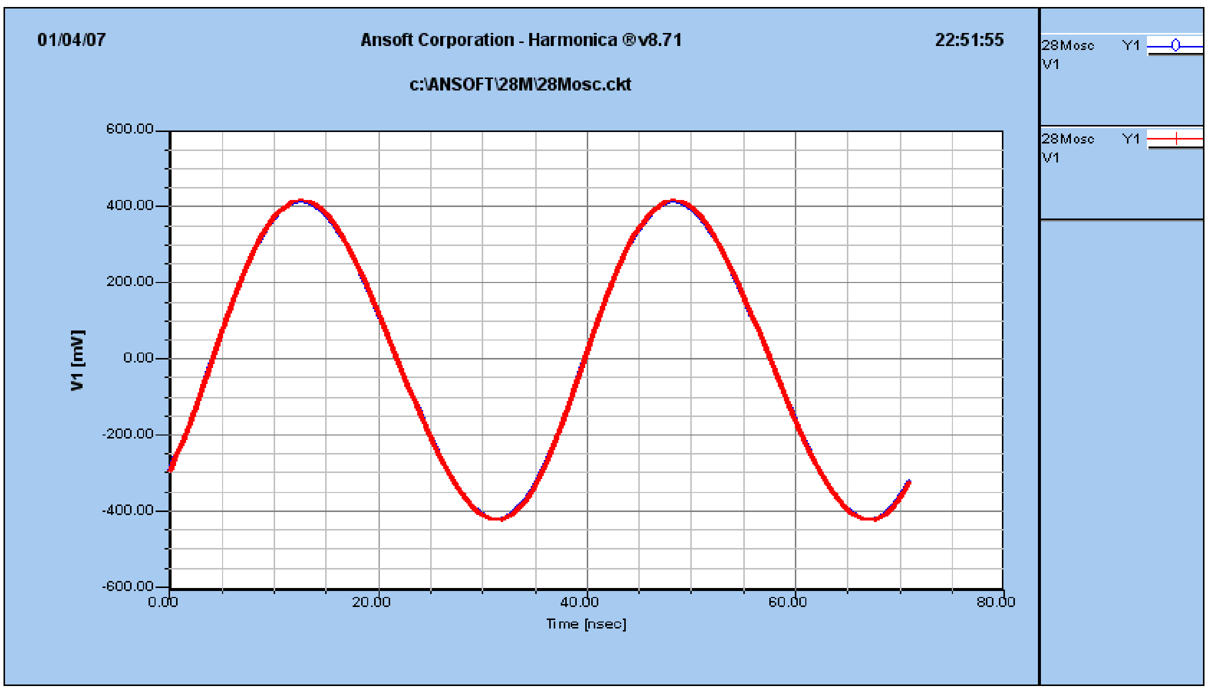


Output spectrum with out LP filter at output

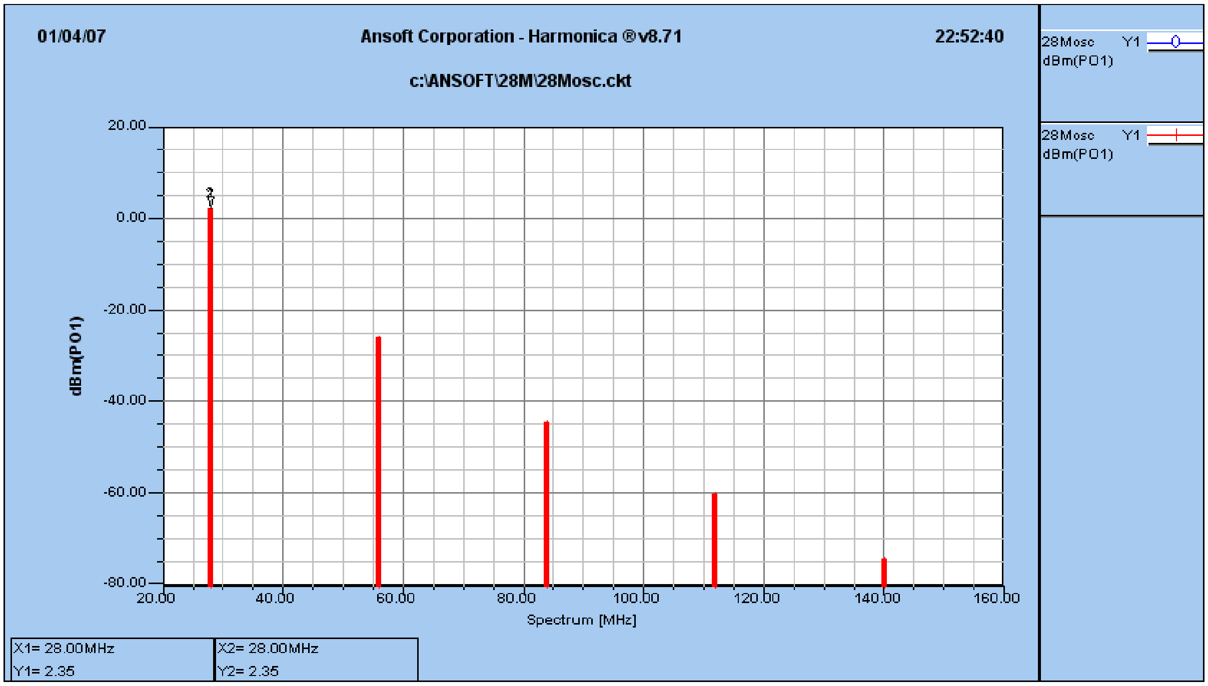
Clapp Guriout OSC 28 MHz with LP



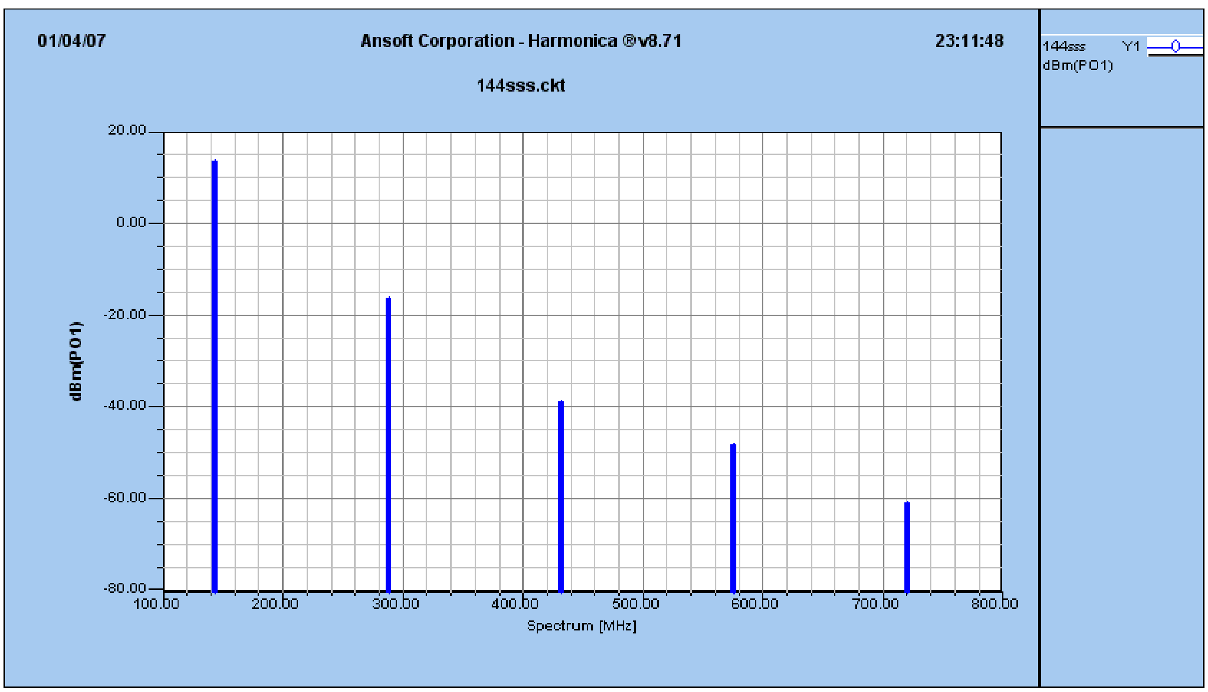
Red line is 28 MHz oscillator with switching diodes



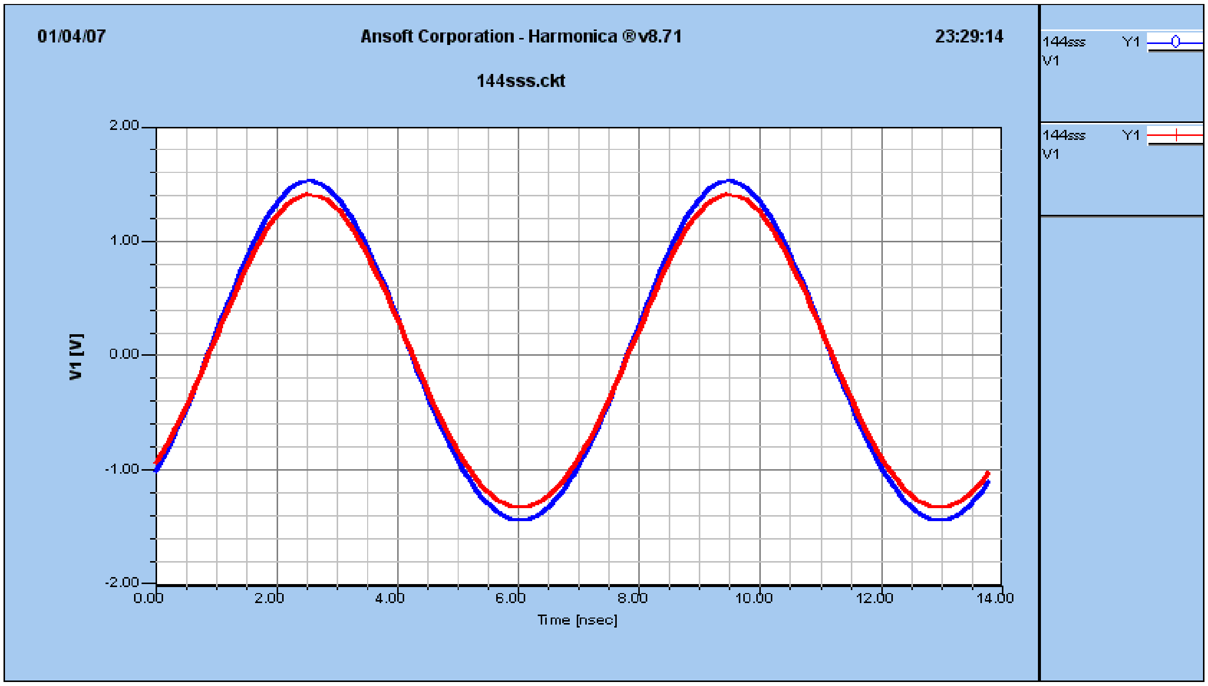
Output waveform with LP(low pass)



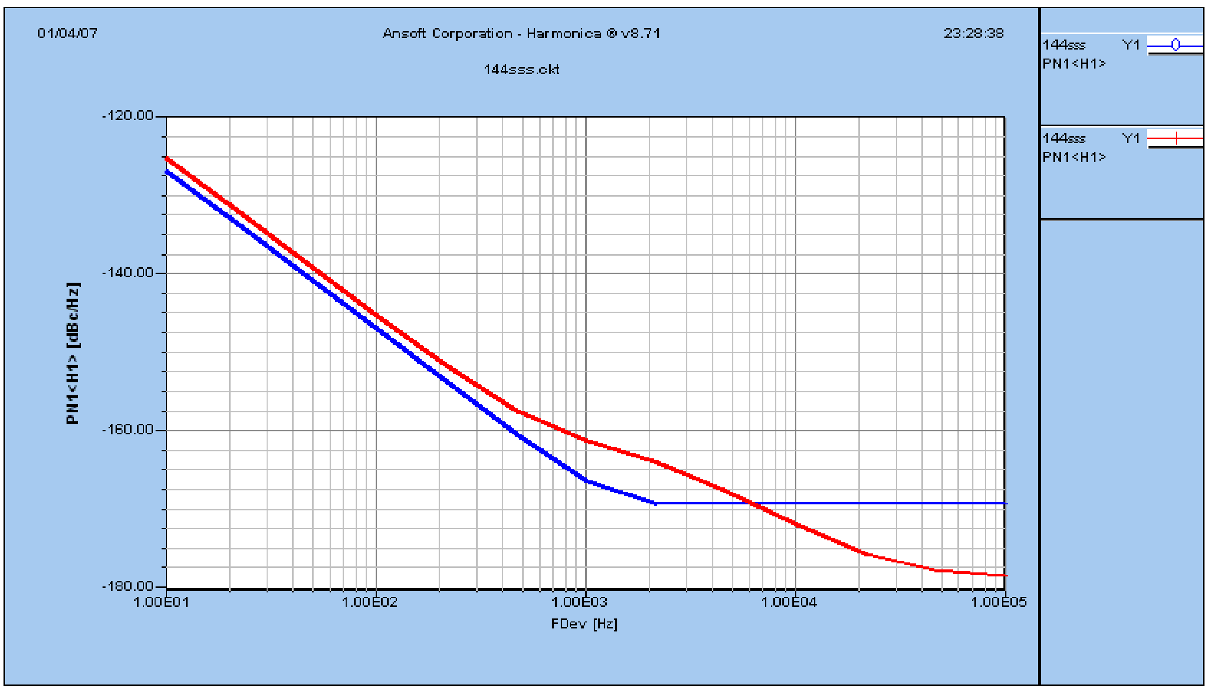
7 th overtone 144 MHz Clapp- Guriout oscillator with xtal Qo=75000 C1=33pf C2=33pf L1=80 nH LP C6=82pF L2=30nH L7=56 pF



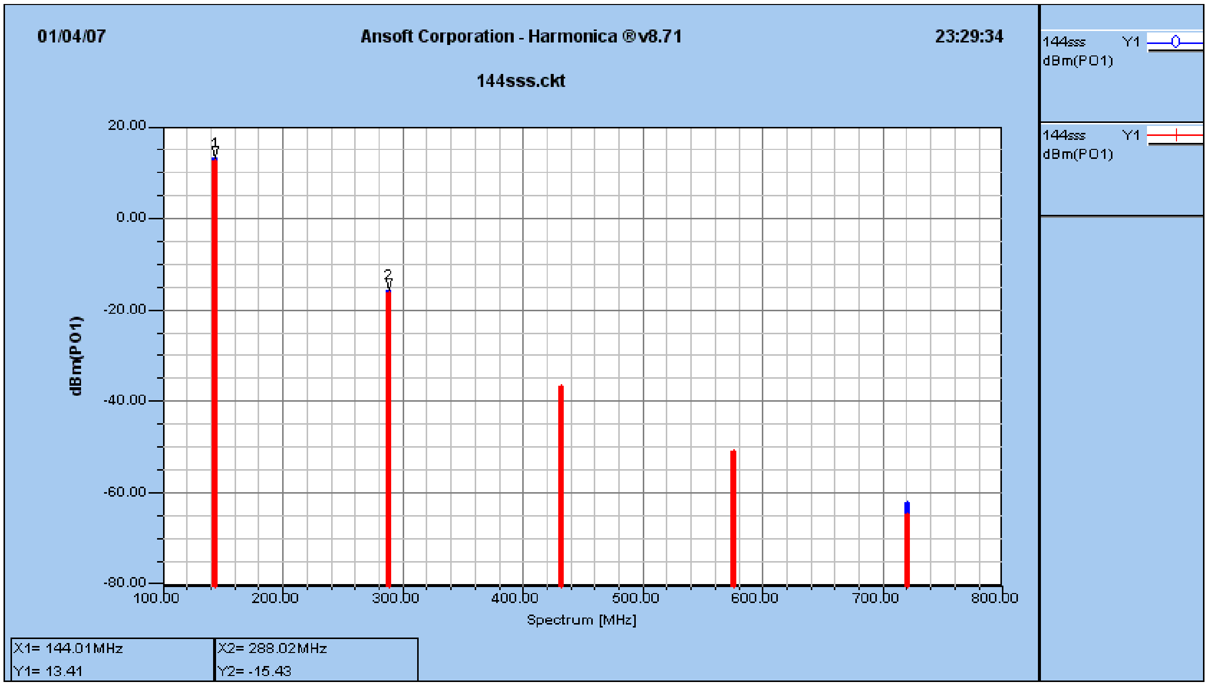
Output spectrum

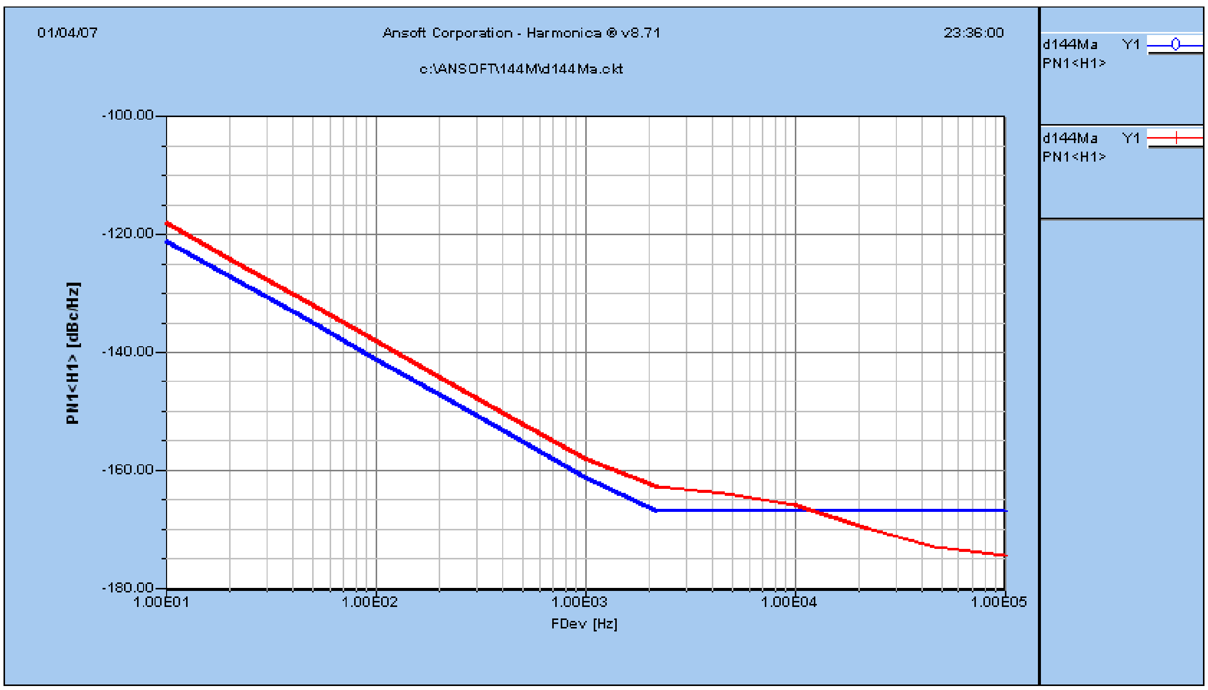


Output waveform

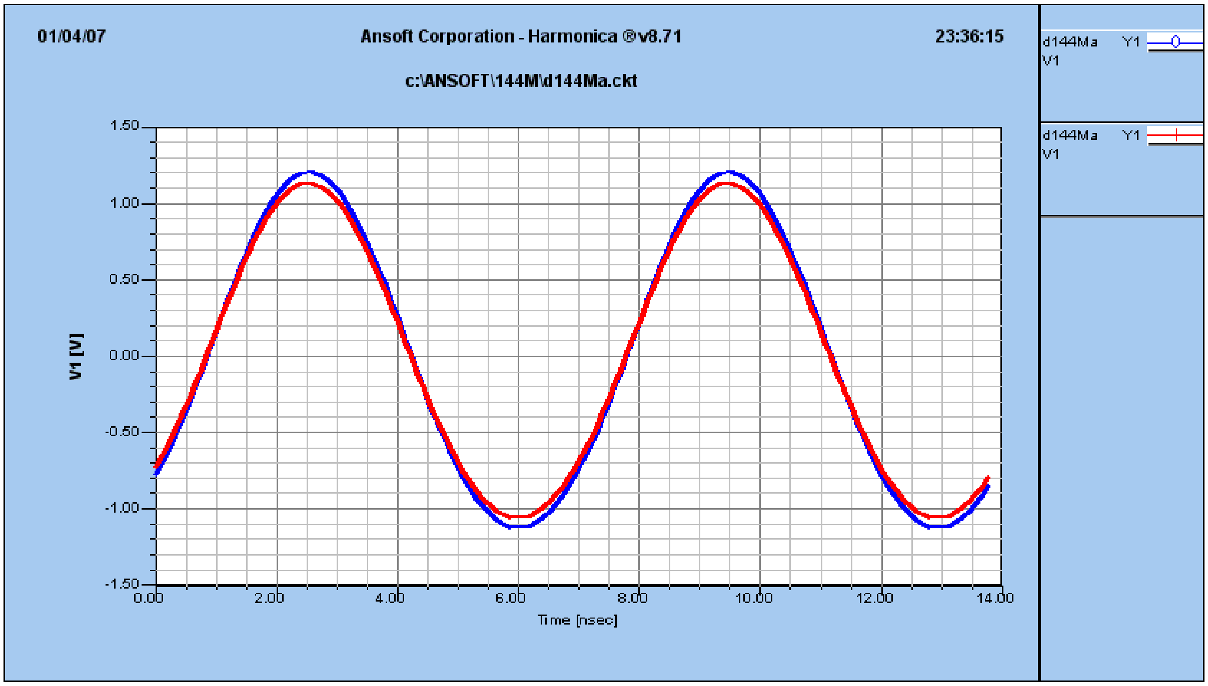


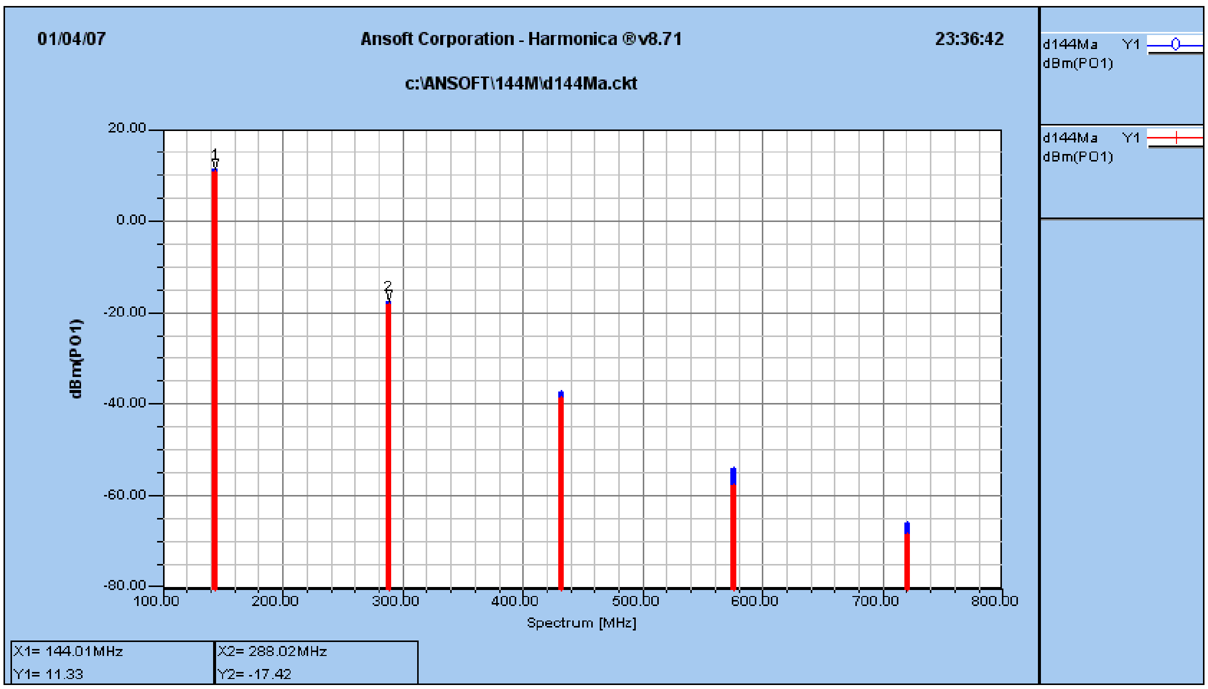
Oscillator phase noise 144 MHz XTAL Qo=40000 C1=33pf C2=33pf L1=80 nH LP C6=82pF L2=30nH L7=56 pF



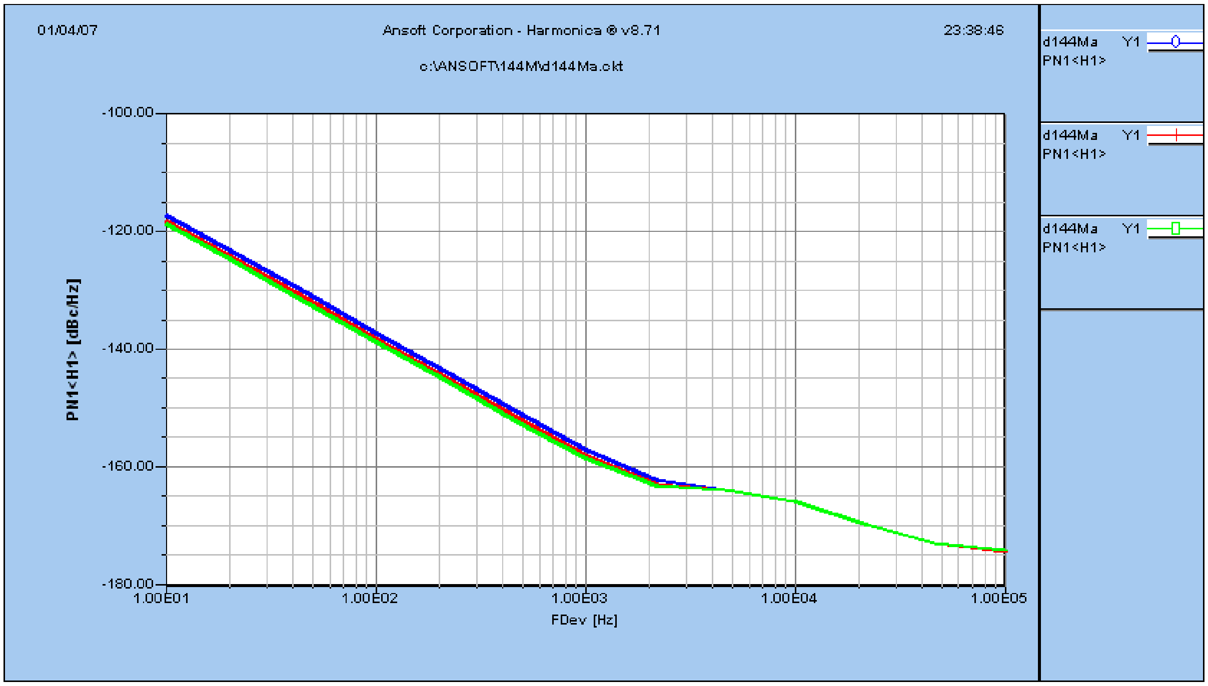


Oscillator phase noise without switching (blue) and with switching diodes (red)

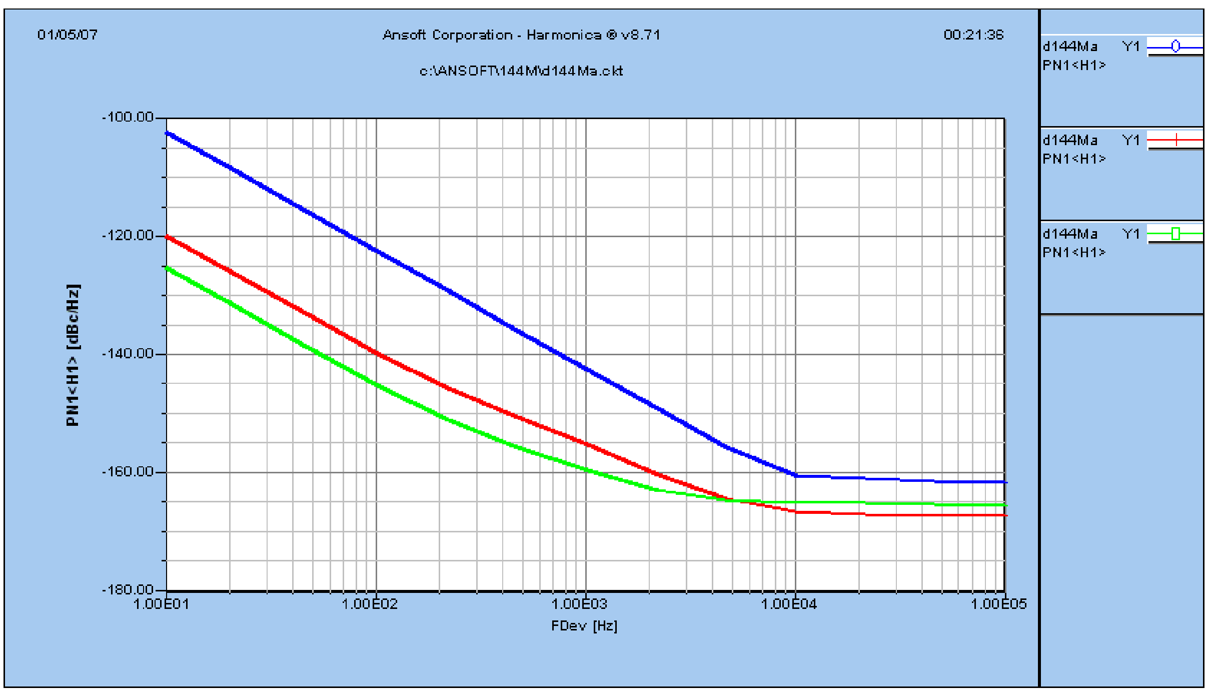




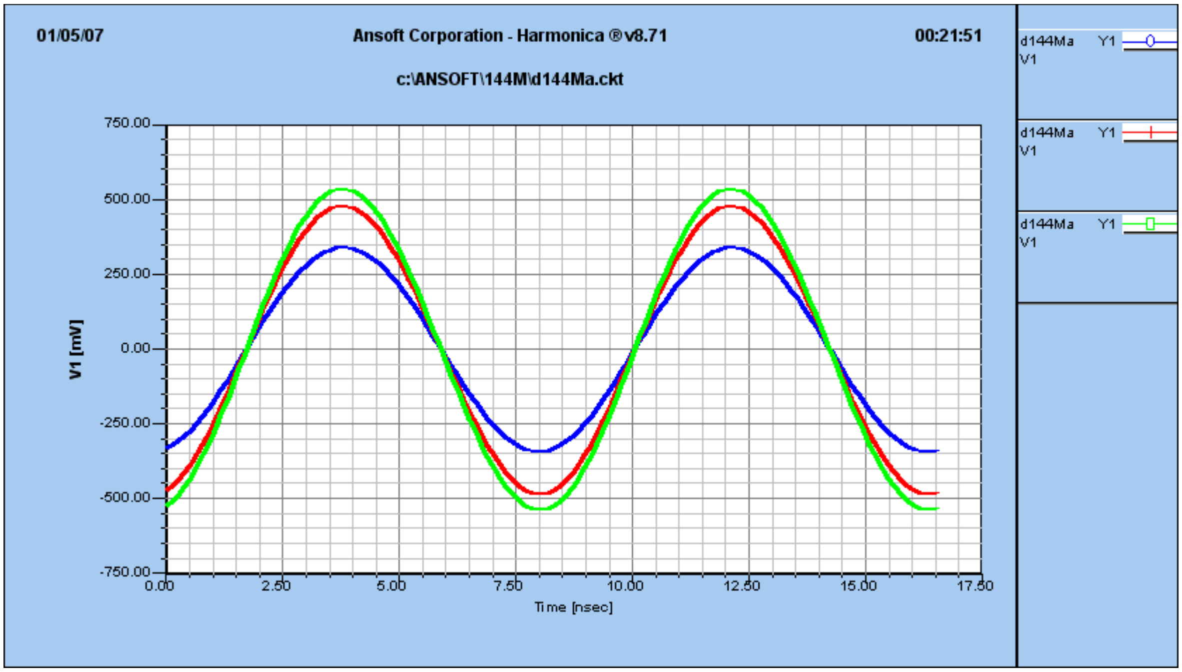
Phase noise with L1=70(blue), 80, 90 (green) nH respectively



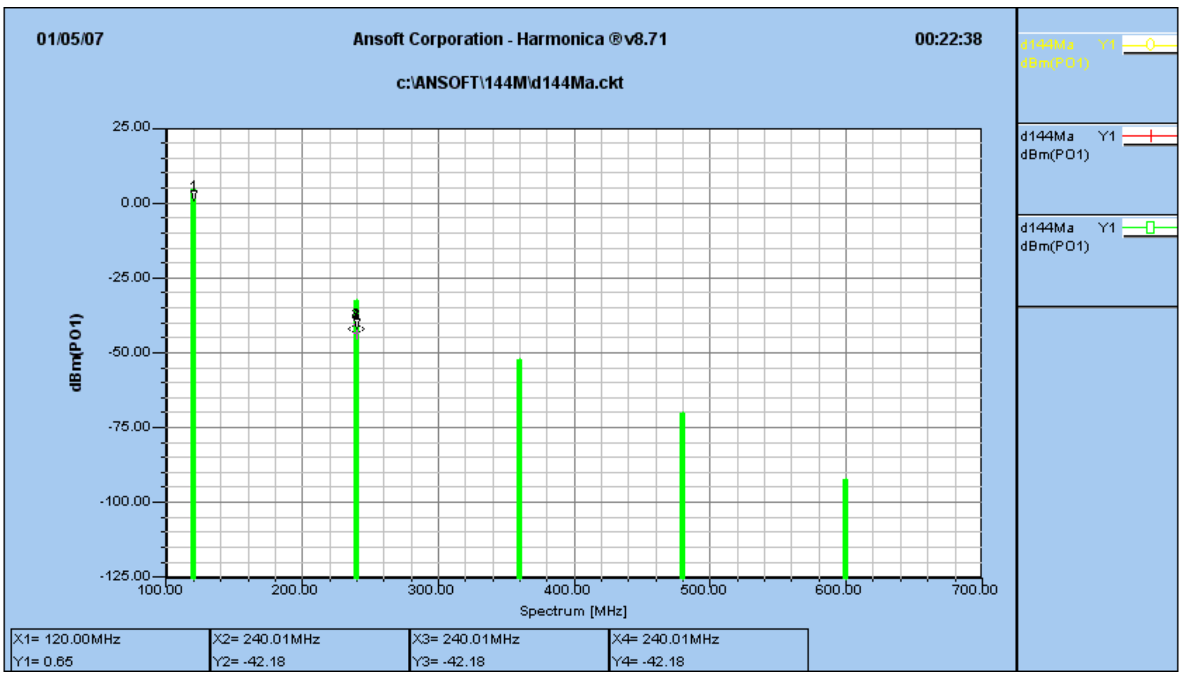
REF OSC 120 MHz Qo=40000(blue) 60000(red) 80000 (green) C1=39pf L1=150 nH(q=120) 9 turns self supported coil ID=5 mm length 10 mm Cu=1 mm Qo=118 C2=39 pF and LP C6=100pF L2=40 nH C7=68 pF (L1=100 nH Qo=70 blue 120 red 200green)



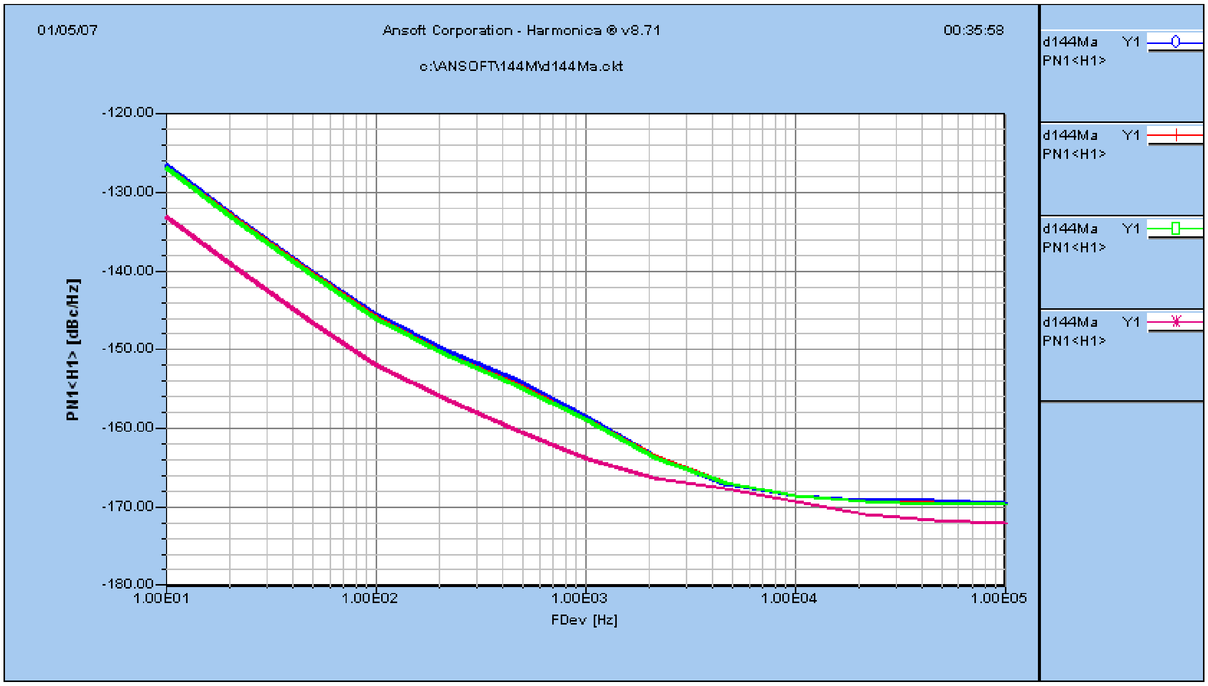
Oscillator phase noise

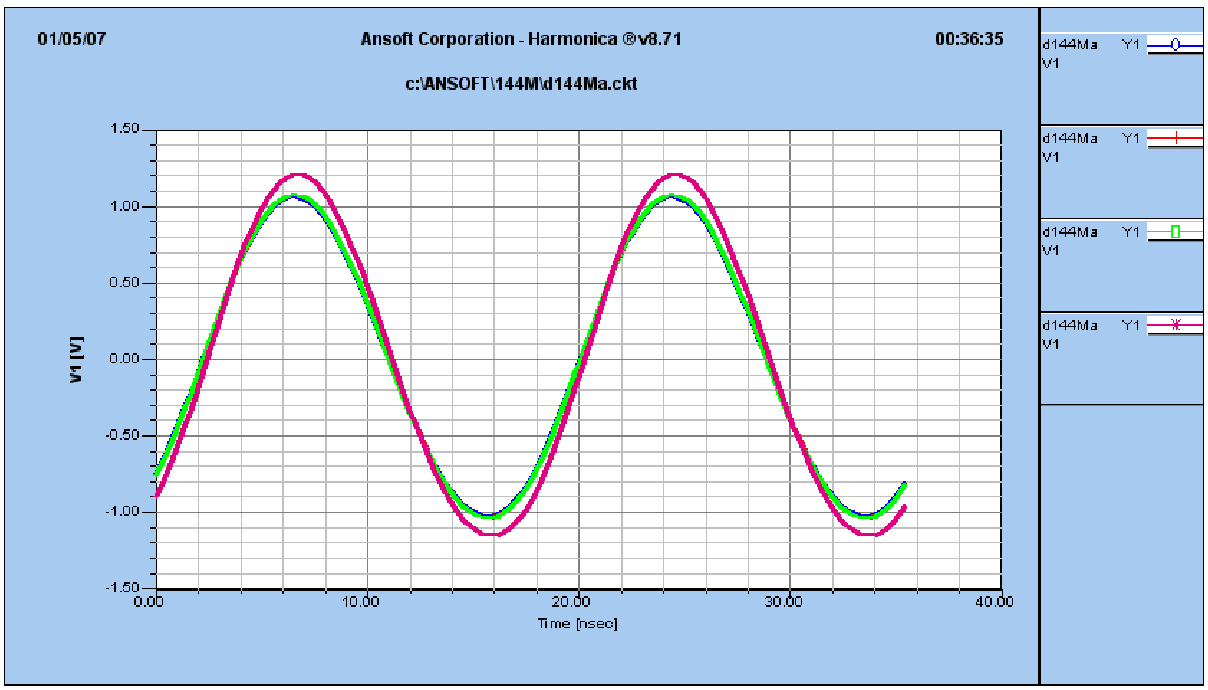


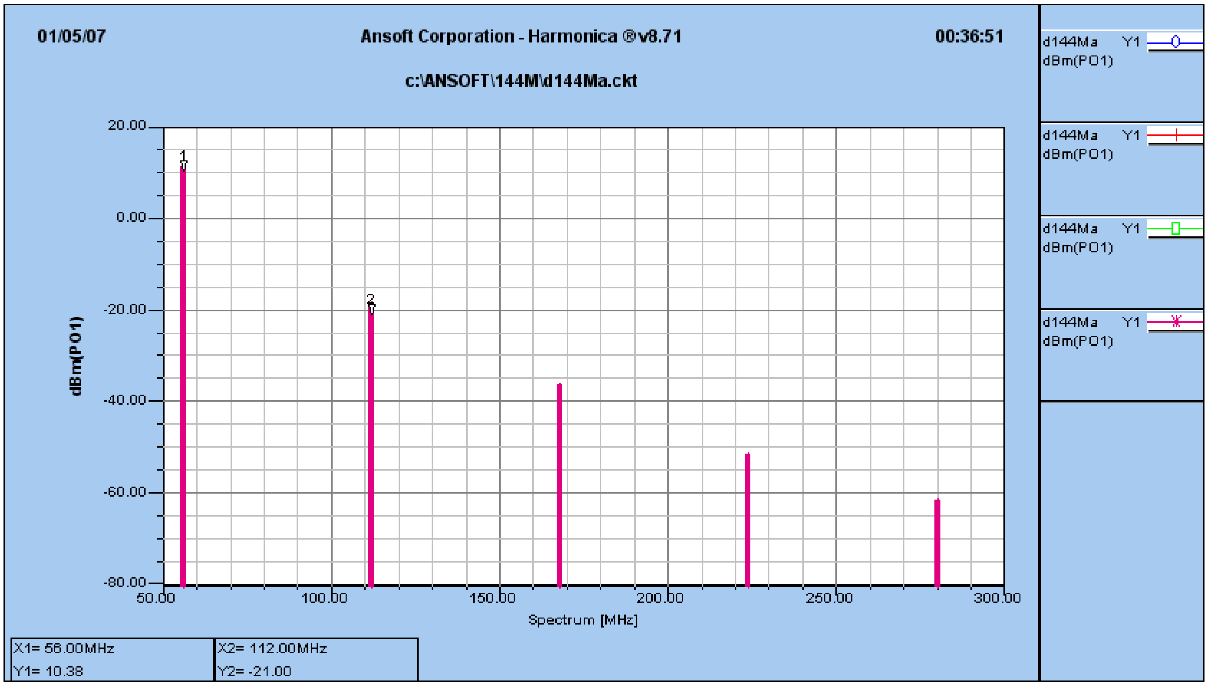
Output waveform for different xtal Qo



Clapp-Guriett oscillator 56MHz Qo=50000 red Qo=80 000 C1=68pF L1=330nH C2=68 pF LP C6=220pF L2=80nH C7=150Pf


01/05/07
Ansoft Corporation - Harmonica ® v8.71
00:35:58
c:\ANSOFT\144M\d144Ma.ckt
PN1<H1> [dBc/Hz]
-120.00
-130.00
-140.00
-150.00
-160.00
-170.00
-180.00
1.00E01
1.00E02
1.00E03
1.00E04
1.00E05
FDev [Hz]
d144Ma Y1
PN1<H1>
d144Ma Y1
PN1<H1>
d144Ma Y1
PN1<H1>
d144Ma Y1
PN1<H1>


01/05/07
Ansoft Corporation - Harmonica ® v8.71
00:36:35
c:\ANSOFT\144M\d144Ma.ckt
V1 [V]
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
0.00
10.00
20.00
30.00
40.00
Time [nsec]
d144Ma Y1
V1
d144Ma Y1
V1
d144Ma Y1
V1
d144Ma Y1
V1



I made great effort to make different projects and share them with all who are interesting for. Anyway send me your comments positive or negative, results or photos of your realization please.

VY 73/72 and GL in homebrew Tasa YU1LM/QRP
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